INTERAVIA

REVIEW OF WORLD AVIATION

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Preview of Farnborough 1958

The Bomarc Weapon System

VOLUME XIII

No 9/1958

FIAT
AVIATION

FIAT G 91

Bristol Orpheus Jet Engine

The NATO Light Ground Attack Fighter. 1 airplane — 3 tasks:

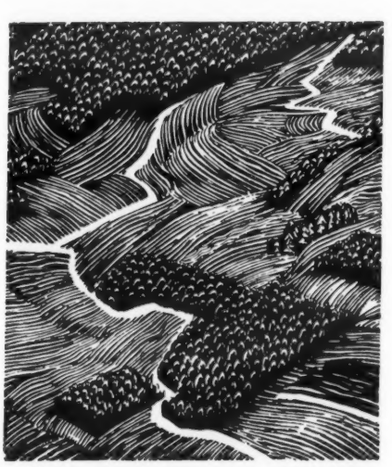
Tactical support — Machine guns or cannon, bombs, rockets, guided missiles.

Armed reconnaissance — Planimetric photography with the possibility of destroying moving targets such as guided missiles.

Special reconnaissance — Day and night photography. Infrared ray photographic surveys, television.

NATO asked for two airplanes to perform two essential tasks. FIAT provided a single airplane capable of rapid conversion for carrying out three essential tasks. *One* airplane able to perform the two required tasks in addition to the vital mission of armed reconnaissance.

Essential advantages of this airplane: ability to land on or take off from hastily prepared or grass runways, very short take-off and landing runs; light weight; low first cost and operating charges.



FIAT — DIVISIONE AVIAZIONE Corso Giovanni Agnelli 200 — Turin (Italy)

INTERAVIA

Review of World Aviation

Volume XIII **No. 9** **September 1958**

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FRONT COVER : English Electric P.1B supersonic fighter (two Rolls-Royce *Avons* with reheat), which is scheduled for squadron service in 1959. The whole aircraft has been designed as a weapons system. One of the two de Havilland *Firestreak* guided missiles carried can be discerned in the picture. Armament also includes two 30-mm Aden cannon. Other features are the auxiliary tank beneath the fuselage and the conical central body in the air intake duct to take the new Ferranti AIRPASS (Airborne Interception Radar and Pilot's Attack Sight System) fire control system.

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MORE NEW *murphy* EQUIPMENT

Several new items of Murphy electronic equipment will be shown for the first time at the S.B.A.C. Display at Farnborough from the 1st—7th September inclusive, including the following:

MR 310 T All-transistorised P.A. equipment

The first British all-transistorised P.A. equipment with a power output of 40 watts and a weight of less than 8 lbs. The unit is contained in a 1/4 ATR case and has separate music and speech inputs, full switching facilities, and an override feature.

MR 380 Airborne Tape Reproducer

This is a provisional design to provide background music through the passenger announcement system. The playing time is 2 hours using double track tape and there is automatic reversal for continuous use.

REBECCA 8F

A new version of the now famous REBECCA 8, designed to provide accurate means for supply dropping on military operations. It has both meter and CRT presentation of great accuracy.

MR 347

A Portable Transponder Beacon for airborne or vehicle use. It can also be dropped from aircraft and used in conjunction with the REBECCA 8F as a location beacon for supply dropping operations.

Also displayed will be the current range of communications equipment for both ground and airborne use. They include the MR 80/100 VHF Aircraft Equipment and the MR 880 25-watt aeronautical ground station.

Advice and technical information about the above equipment are available on request from Electronics Division, Murphy Radio Limited, Welwyn Garden City, England

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For Aviation Safety . . .

we design and construct complete electrical installations for airports:

- Airport lighting systems
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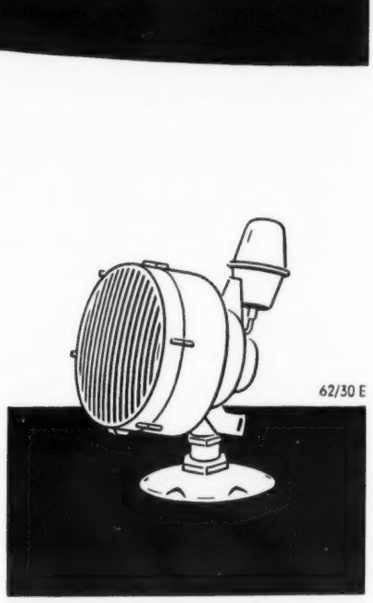
- Ceiling projectors
- Power supply with remote control
- Special airport cables
- Starter rectifiers for starting aero-engines



SIEMENS-SCHUCKERTWERKE AKTIENGESELLSCHAFT

BERLIN · ERLANGEN

USERS OF PRATT & WHITNEY ENGINES PROFIT

SERVICE AROUND THE WORLD, wherever aircraft are based or wherever they fly, is provided for owners and operators of Pratt & Whitney engines. Field service representatives on duty outside the United States last year served all the places indicated on the map above. They travelled 6½ million miles during 1957.

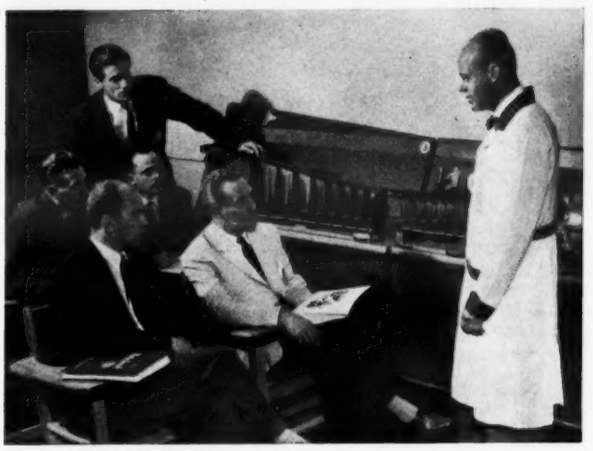
FROM THOROUGH CUSTOMER SUPPORT PROGRAM

Operators of Pratt & Whitney engines receive invaluable assistance from the broad and comprehensive customer support program conducted by Pratt & Whitney Aircraft around the world. The object of the program is to insure the dependable, efficient, and economical operation of Pratt & Whitney engines.

As an example, the world's largest staff of aircraft engine technical representatives serves operators of Pratt & Whitney engines on every continent. Three hundred highly trained engine experts provide authoritative, up-to-the-minute advice on maintenance, overhaul, spare parts, tools, and operations. To keep abreast of major technical advances, they return periodically to Pratt & Whitney in the United States for refresher courses and advanced training.

In addition, airlines and fleet operators are assisted by Pratt & Whitney airlines engineers. They act as operations consultants, offering guidance on operating techniques and engine performance. The airlines engineers often fly with the carrier's own crews to provide advice in the actual service environment.

In a large, modern service school near the Pratt & Whitney plants, courses are conducted for airline supervisory personnel and maintenance men, for representatives of airframe companies, and for the military. Now in its 20th year, this school has trained more than 15,000 men, including representatives from airlines all over the world. Current courses include jet engine familiarization for management and supervisory personnel; planning courses for managers of overhaul and maintenance, and courses covering specific overhaul and maintenance procedures. About 600 airline representatives are scheduled for jet engine courses during 1958 and 1959. Pratt & Whitney's superior customer service will, of course, continue with the coming of commercial jet aviation . . . as the world's leading airlines begin to fly their Pratt & Whitney powered Boeing and Douglas jet liners.



THOROUGH TRAINING is given to customer personnel. Factory experts teach engine theory, operation, and maintenance and overhaul in a modern school in Connecticut. Shown here, representatives of Qantas, SAS, and Air France study the Pratt & Whitney JT3 jet engine, which will power many of the Boeing 707 and Douglas DC-8 jet liners soon to enter service.

AIRLINES ENGINEERS provide special services for fleet and airline owners of Pratt & Whitney engines, advising on engine operation techniques and engine performance. The airlines engineers often fly with airline crews to offer guidance in the actual flight environment.

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23
1957: 2600 m
23
23
1960: 3900 m
GENEVA
is preparing
for the jet aircraft age
GENEVA
AIRPORT

Fairey flies the first Vertical Take-off Airliner

Adding achievement to achievement, Fairey Aviation have now built potentially the most important transport aeroplane in the world, the Fairey Rotodyne.

Carrying 48 passengers or 4½ tons of freight it takes off vertically as a helicopter and having gained height flies forward as a normal twin-engined airliner.

It is the most adaptable rotary-wing aircraft in the world and the first to offer operating economy directly comparable to that of fixed-wing aircraft over ranges of up to 400 miles.

The arrangement within the Rotodyne's capacious fuselage can readily be adapted to suit civil or military applications.

Powered by two Napier Eland propellor-turbines with Fairey Pressure-Jets at the rotor-tips for take-off and landing.

FAIREY *Rotodyne*

48 passengers · 185 m.p.h. cruising speed

400 miles maximum range.

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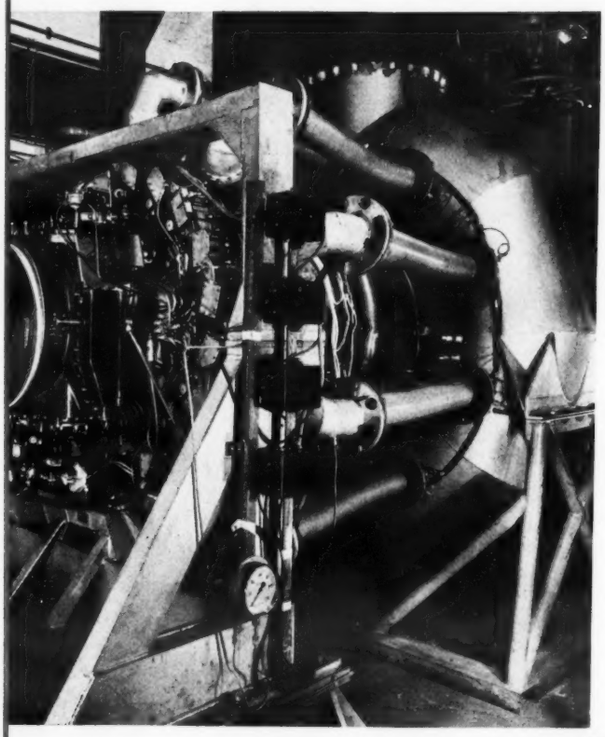
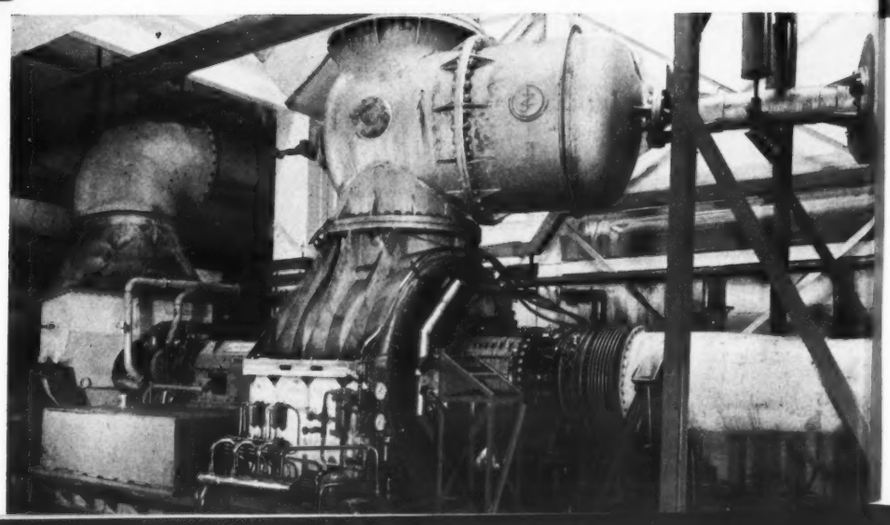
Control room for major test rigs

THE QUEST FOR THE FUTURE

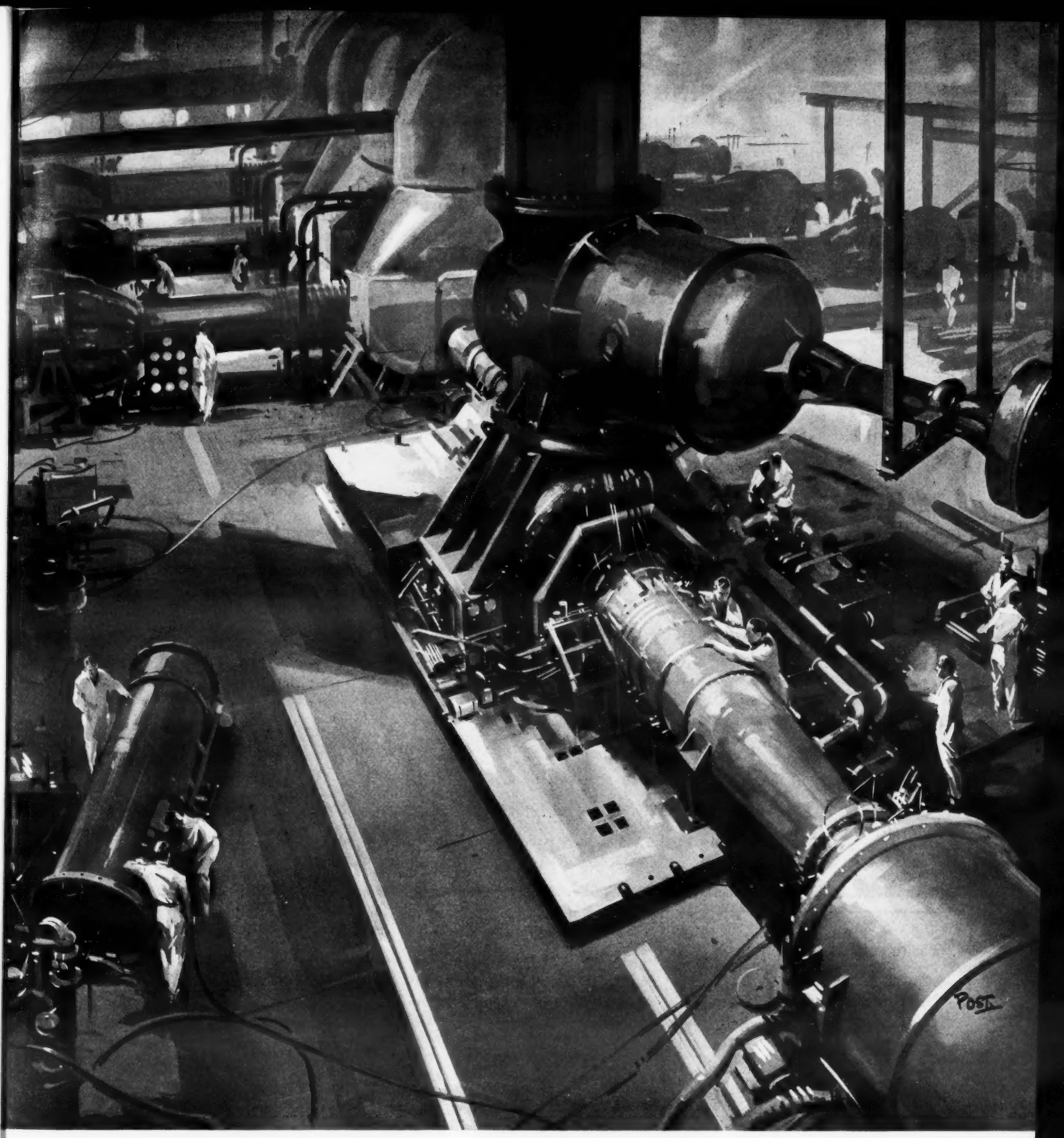


Cooled turbine testing

Vitality of research demands versatility in equipment. At the Halford Laboratory of The de Havilland Engine Company is centred a complete research organisation where a diversity of rigs is actively engaged in today's investigations and is capable of ready application to the problems of tomorrow. The flexible nature of this equipment is exemplified by the 30,000 s.h.p. gas-turbine-powered rig for full-scale compressor testing.



Full-scale axial compressor testing



Continuous research speeds the way ahead.

THE DE HAVILLAND ENGINE COMPANY

LEAVESDEN, HERTFORDSHIRE, ENGLAND

NOW BEING DELIVERED — JET POWERED ELECTRA!

The first prop-jet Lockheed Electras are being delivered this month for scheduled service before Christmas. Fourteen leading airlines throughout the world will inaugurate a new era of jet age service, performance and economy with the Electra in the months ahead. More than just a "new" airplane, the Electra offers travelers a unique flying experience known as:

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You'll enjoy ELECTRA/FLIGHT! Vibration-free, jet-power smoothness lets you write or read with ease. You'll enjoy a big picture window panorama. The wide, spacious cabin allows for more comfortable seating and easy walking in the aisle, and provides space for more efficient stewardess service.

You're comfortable on ELECTRA/FLIGHT!

New radiant heating in the walls and floor surrounds you with even-temperatured warmth. No-draft air conditioning can operate on the ground also.

ELECTRA/FLIGHT saves you time, in the air and on the ground. Four General Motors Allison Prop-Jet Engines whisk the Electra along at almost 7 miles a minute. Because the Electra reaches cruise altitude in a hurry you spend less time with seat belt on...have more freedom to enjoy the journey.

You'll find ELECTRA/FLIGHTS available! Swift in the air, nimble on the ground, Electra brings the jet age to the smaller communities, too. It can serve over 1300 of today's airports located in all parts of the world.

Purchased by: Aeronaves de Mexico · American Airlines · Ansett—ANA of Australia
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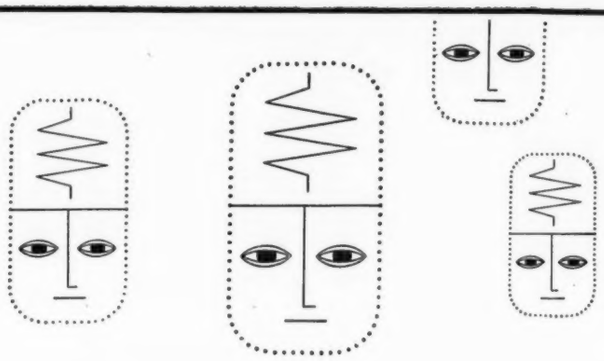

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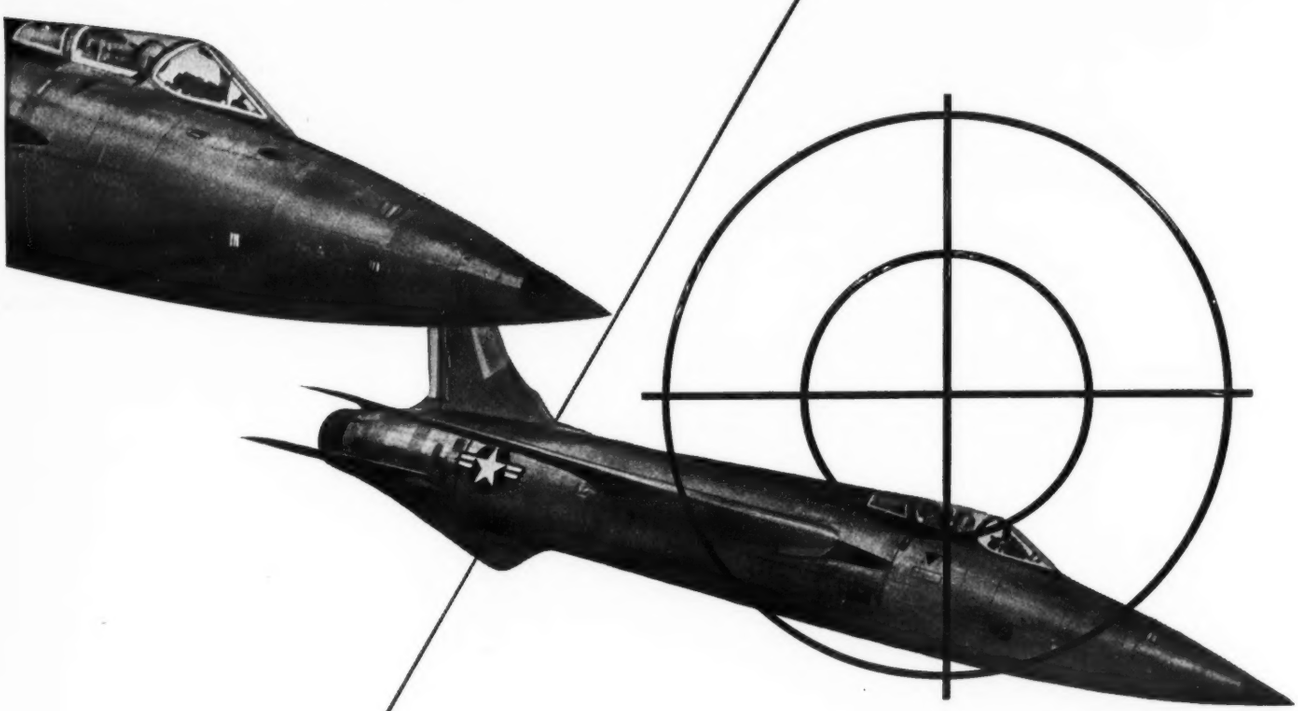

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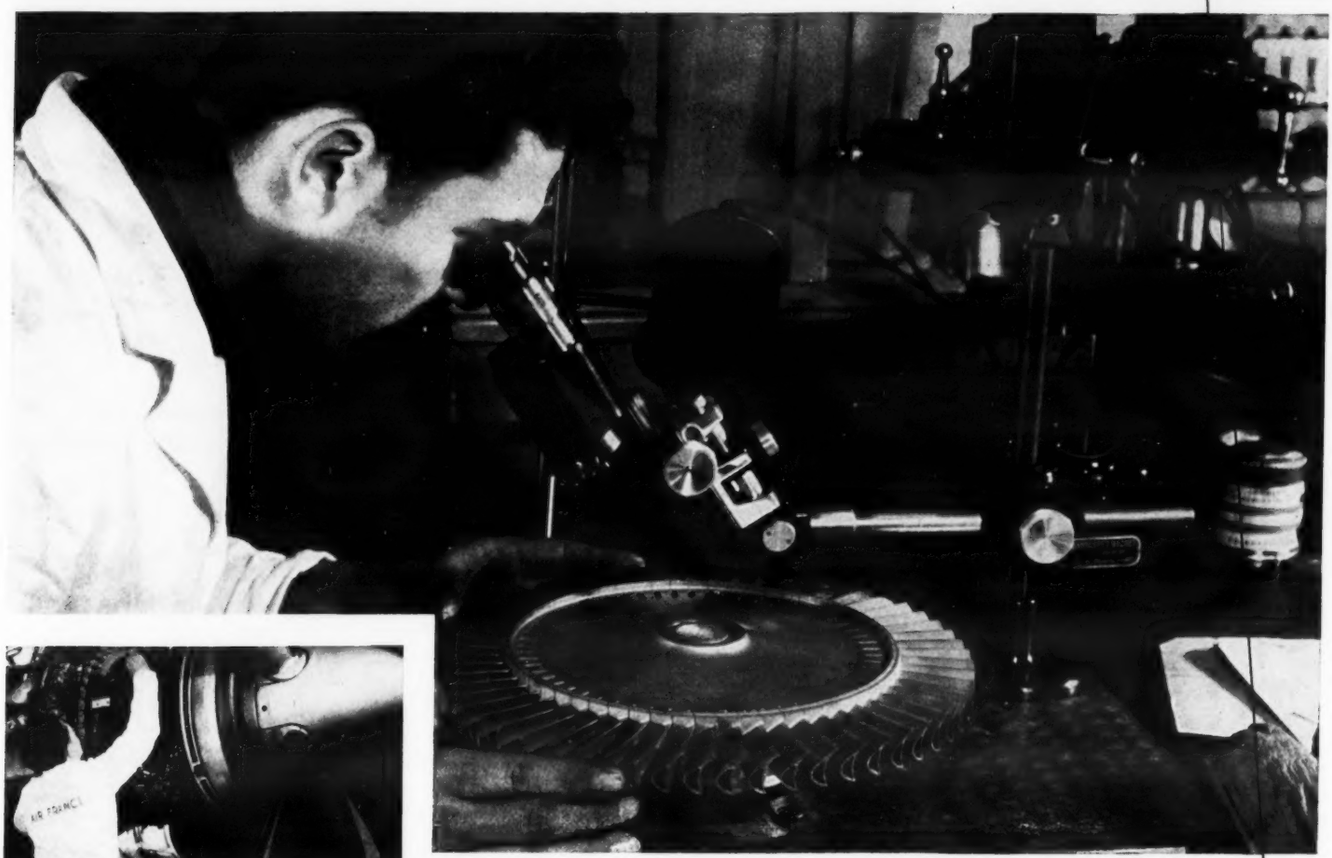
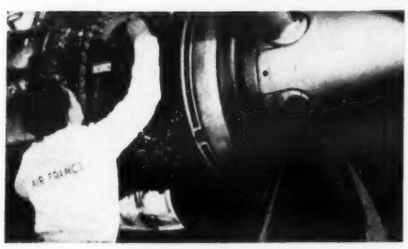
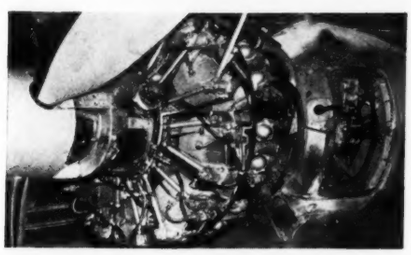
WORLD-WIDE INDUSTRIAL ORGANIZATION







for every take-off Air France presents a new aircraft

In its modern, specially equipped workshops, Air France employs more than 6,000 technicians to inspect and maintain its aircraft.

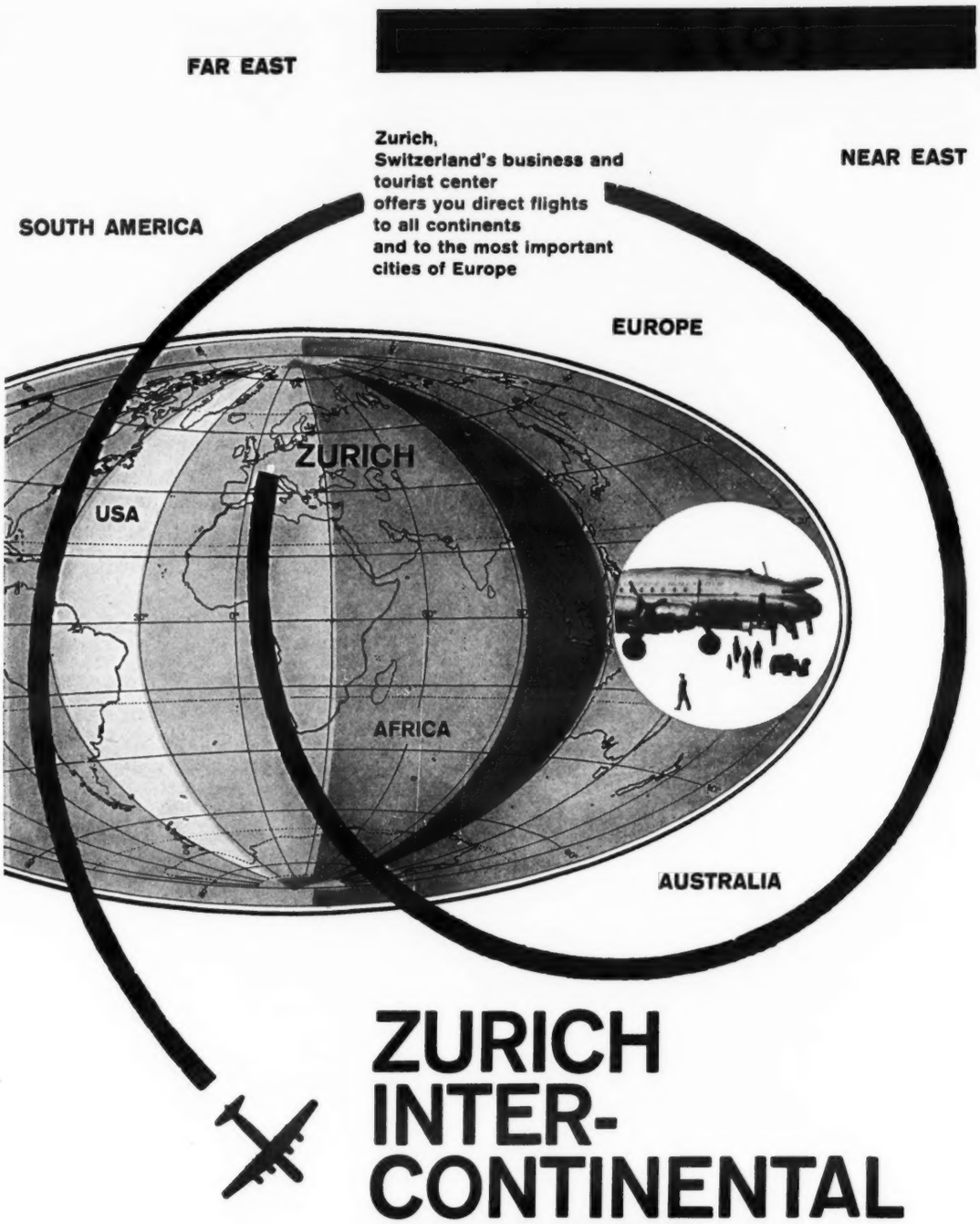
After every flight, the aircraft coming in from a trip is taken to the hangar where all its essential components are examined. After 50 flying hours the check is even more meticulous. Every 150 hours the inspection takes a full day, and every 1,800 hours 4 days.

Engine, propeller blades, airframe, undercarriage, radio and radar equipment, no part or system escapes the specialists' searching examination.

Its far-reaching inspection organization, the size of its fleet and the skill of its elite crews give Air France the qualities which make of it the specialist airline in long-distance services.

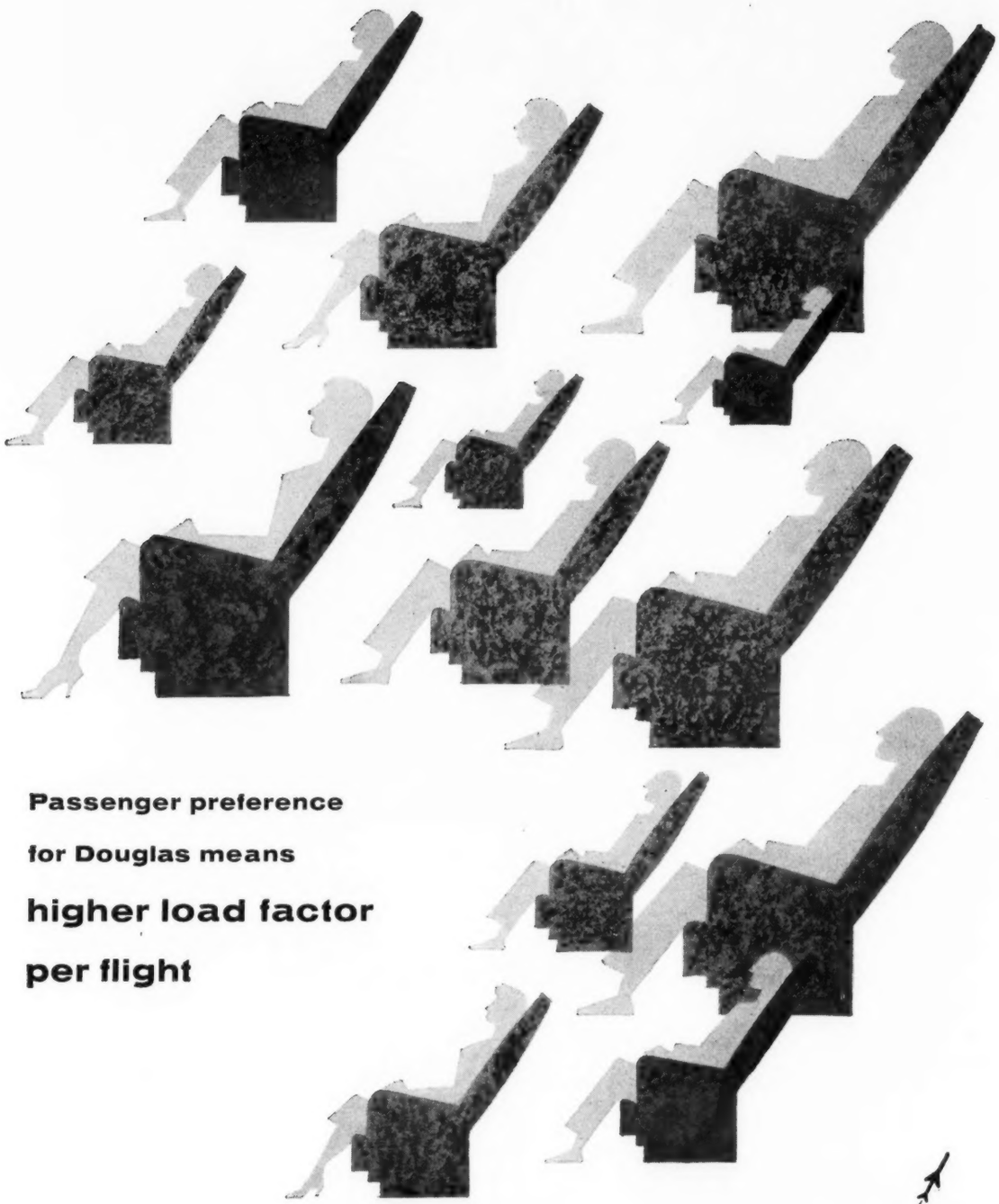
in the forefront of progress...

AIR FRANCE
THE WORLD'S LARGEST AIRLINE



ZURICH INTER-CONTINENTAL AIRPORT

Important link in World-Wide Air-Traffic



Passenger preference

for Douglas means

higher load factor

per flight

Airline operators have learned that Douglas aircraft provide the key factors for profit-making.

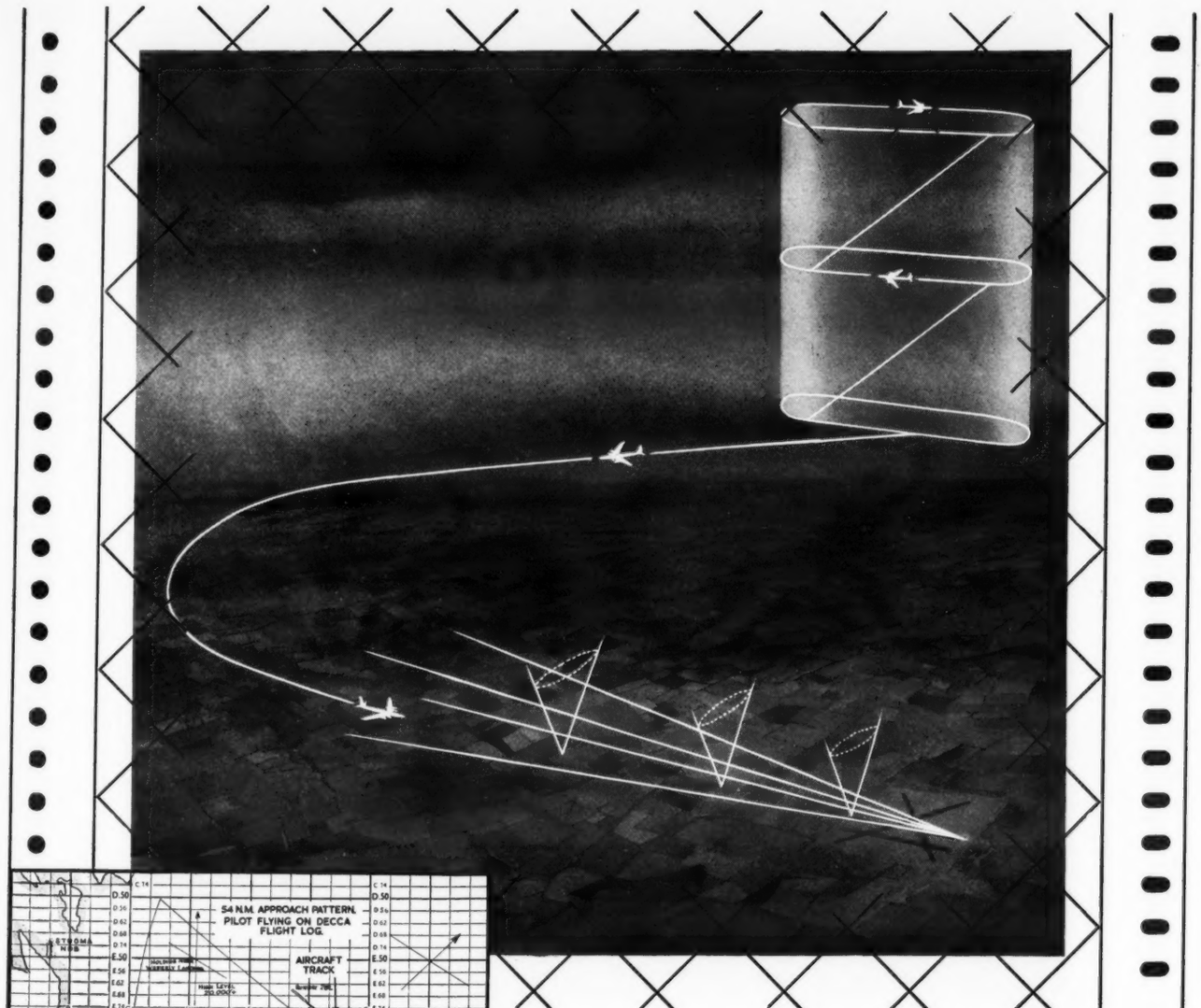
The world-wide Douglas reputation for dependability, speed and comfort influences both new and veteran air travelers to prefer airlines flying DC airplanes. The result is an increased traffic volume.

Combine this with the high productivity of Douglas airplanes and their low operation and maintenance costs and you get more gross income per airplane . . . and more net in relation to gross income.

Higher load factor is another of the reasons so many airlines depend on Douglas DC equipment.

DOUGLAS

The most respected name in Aviation



In the trials, held off the Orkneys, the holding area and runway were simulated exactly as for London Airport. In the above chart, used during the trials, the holding area with 4, 6 and 8 minute orbits is clearly shown together with the required track to the runway also clearly marked with altitude checks down to the threshold. With the Flight Log the pilot was able to navigate precisely at every stage of the flight, greatly simplifying the entire holding and approach procedure.

THE DECCA NAVIGATOR

THE WORLD'S MOST ACCURATE NAVIGATOR SYSTEM

THE DECCA NAVIGATOR COMPANY LIMITED LONDON

Decca in the Jet Age

Recent air traffic control trials carried out by the Ministry of Transport and Civil Aviation in a D.H. Comet have proved that, with the Decca Navigator Flight Log, jet aircraft can be navigated accurately regardless of altitude or weather conditions.

No other aid is either suitable or accurate enough for holding at altitude within a defined area. With Decca, such areas can be designated independently of ground facilities and flown exactly regardless of drift. Exhaustive tests showed that, with the Flight Log, pilots were able to leave a holding area with a very high degree of precision, track can be maintained precisely during the descent from the holding area to touch down, giving the pilot a continuous check of altitude against distance from touch down.

Knowing exactly where he is at all times by reference to his pictorial display, the pilot has an independent check on radar control, and being able to navigate himself accurately in the terminal area his R/T communication with such control is greatly reduced. The safety of all aircraft is increased by the consequent lightening of the load on the Radar controller. Improved accuracy in time and position keeping, results in the reduction of delays enabling the maximum landing rate to be achieved.

INTERAVIA

Deadline Notes

No. 9, 1958

• **President Eisenhower** has asked Congress to vote $125,000,000 to operate the newly-established National Aeronautics and Space Agency. NASA was created on July 29th when the President signed the bill providing for its formation. According to James Hagerty, the Presidential Press Secretary, an additional $117,000,000 will be transferred to NASA from the Defense Department, making an overall total of $242,000,000 available. The Defense Department has at its disposal a separate $294,000,000 for military space projects. In announcing the signature of the new bill, the President said : "The National Advisory Committee for Aeronautics (NACA), with its large and competent staff and well-equipped laboratories, will provide the nucleus for NASA... the combination of space exploration responsibilities with NACA's traditional aeronautical research functions is a natural evolution." Dr. Hugh L. Dryden, head of NACA, estimates that the new agency will be functioning within two or three months. Although Dr. Dryden has been top candidate for the position of NASA administrator, reports from Washington indicate that the President is looking for a "top-level, political appointee". The administrator will be responsible for planning, directing and conducting aeronautical and space activities and will be responsible to the President who, assisted by an eight-man advisory council, will be in direct charge of the agency. The council will include the Secretaries of State and Defense, the Agency Administrator, the Chairman of the Atomic Energy Commission, one federal official to be named by the President and three members appointed by the President from the fields of science, education, engineering or public affairs.

• **Le Bourget** is to be the first French airport to be used by scheduled airline jet transports. The Paris Airport Authority has decided to allow Tu-104s operated by Aeroflot and Ceskoslovenské Aerolinie to use Le Bourget. Permission was granted on condition that the two companies abide by the following regulations : All landings and take-offs must be made during daylight hours ; the climb to a height of 500 metres after take-off must be rapid ; landings may be made only toward the south on the north-south runway, or toward the west on the east-west runway ; take-off may be made only toward the north on the north-south runway, or toward the west on the east-west runway. The same permission is expected to be granted this autumn to Pan American World Airways for the Boeing 707 if the provisional authorization granted to PAA for New York is confirmed. The regulations and the choice of Le Bourget rather than Orly were designed to assure the safety of the Paris population and to confine the noise of the jets to the outskirts of the city. Orly Airport may not be used for jet operations for the time being since use of the north-south runway would involve flight at a low altitude over built-up areas in the vicinity. The east-west runway, which had been closed to traffic since May 1st because of construction work, was re-opened on August 4th.

• **Consorzio Servizio Elicotteri per i Comuni Siciliani (SECOSI)** is the name of a special consortium which has been created with headquarters in Trapani to operate helicopter services between Erice, Marsala, Mazara, Castelvetrano and Calatafimi, as well as the islands of Egadi, Ustica and Pantellaria. The group represents the following organizations : the Trapani Commodity and Agricultural Exchange, the Trapani provincial administration, the local authorities of the towns and islands to which the services are planned, and the Bank of Sicily.

• **Vitor Manuel Carneiro Veres** has been named as Director-General of Civil Aviation in Portugal to succeed General Humberto Delgado who was an unsuccessful candidate in the recent Presidential elections. General Delgado is now available for a new posting by the Air Ministry.

• **British Overseas Airways Corporation** has now concluded its programme of development and training flights with the *Comet 2E* aircraft. The programme has covered a total of 3,725 hours of flying and has included regular flights from London to Beirut and to North America. As a result, much development work has been done in preparation for the introduction into service of the *Comet 4*, which is likely to begin commercial operations with BOAC later this year on the North Atlantic route.

• **American Airlines** has announced orders and options for an additional 95 jet transports for the North American routes. This brings the company's total jet and turboprop transport purchases up to the impressive total of 110, with options on an additional 50 aircraft. The new orders are for a firm 25 Boeing 720s, with options on a further 25, and for 25 Convair 880s, also with an option on an additional 25. At the same time the original order for 30 Boeing 707s has been reduced to 25.

• **J. H. Carmichael,** long-time President of Capital Airlines and lately Chairman of the Board of Directors has handed in his resignation for personal reasons. A company announcement said that his resignation was accepted with regret.

• **Transcontinental S. A.** has now placed a firm order for four Convair 880 jet airliners which are to be introduced on the Buenos Aires-New York route in mid-1960.

• **C. A. Butler,** former Managing Director and founder of Butler Air Transport, at a press conference early in August announced plans for a new Australian domestic airline utilizing Sud-Aviation *Caravelles*. According to a Reuter report, Butler was speaking on his return from Europe and indicated that six *Caravelles* were planned to operate for the new airline from 1960. Butler refused to state whether he had actually purchased or ordered *Caravelles*.

• **The first Boeing B-52G** has now come off the production line at Wichita. The B-52G differs from earlier versions in that it has more powerful jet units and a modified fuel system (the so-called "wet wing" with integral wing tanks). The G-version also has improved performance with range considerably increased. Two GAM-77 *Hound Dog* missiles can be mounted below the wings.

• **Bell Helicopter Corporation** is seeking to have the turbine-powered HU-1 helicopter, developed for the U.S. Army, certificated for civilian use. (The service test version of the HU-1 for the U.S. Army is designated YH-40). The civil version of the helicopter will be designated Bell 204, and the company announces that deliveries for commercial utilization will be available as soon as the production programme for the U. S. Army permits.

• **Allison Model 250** is the designation of a new lightweight 250 h.p. turbine engine which will be manufactured in two versions : a turboprop version, Model 250-B2, and a turboshaft version, Model 250-C2 for powering helicopters.

• **The CAA** has now accepted the 150-hour type test certificate for the *Eland NEl.6* of 3,500 s.h.p. Good progress is being made with the CAA trials of the *Eland*-Convair 340 in the USA, and certification of both the 340 and 440 with *Eland* turboprops was expected about the middle of August.

• **Champion Spark Plug Company,** Toledo, announces that the 14th Annual Champion Aviation Spark Plug and Ignition Conference will be held from October 8th to 10th, 1958, at the Secor Hotel, Toledo. Champion is again sponsoring this conference. Participating will be representatives of the airlines, aircraft engine manufacturers, airframe manufacturers, ignition equipment manufacturers, oil companies, governmental agencies and other bodies having an interest in operational, maintenance and development aspects of aircraft ignition systems.

• **The second prototype Avro Arrow** made its first "shake-down" flight at Malton Airport on August 1st. The aircraft was flown for 90 minutes by Avro's chief test pilot, Jan Zurakowski. The first high-speed tests for the *Arrow* are scheduled to begin in the second half of August when Avro employees return from their annual vacation. A later development will come in six to nine months when the Mark II model comes off the production line. It will be powered by Canadian *Iroquois* engines which will replace the Pratt & Whitney engines in the Mark I.

• **The DHC-4 Caribou** twin-engine multi-purpose aircraft, built by de Havilland Aircraft of Canada Ltd., began flight testing at the end of July. First deliveries, to the Canadian Government (who has ordered them on behalf of the U.S. Army), are scheduled for 1959. With its two 1,450 h.p. Pratt & Whitney R-2000 piston engines, the DHC-4 can carry up to 28 fully-equipped troops or 2.5 tons of freight.

• **Vickers-Armstrongs** is making good progress with the private venture Type 891 infantry anti-tank weapon. Tests have proved encouraging and the weapon should be ready for production by the end of the year.

• **Future Vautour projects** are being studied by Sud-Aviation ; these include a robot version (without pilot), a tanker version for in-flight refuelling, and a day and night photographic reconnaissance version.

• **The Pilatus Flugzeugwerke AG,** Stans, Switzerland, manufacturers of the P.3 training aircraft, has developed and is currently building a first batch of five small transports, designated C.6. The aircraft is powered by a Lycoming GSO-480-A1A6 of 340 h.p. ; it is scheduled to make its first flight in mid-1959. The C.6 will be capable of transporting payloads of up to 1,100 lb. over distances of 460 nautical miles ; it is quickly convertible into a five-seat passenger version, and is suitable as an air ambulance, an agricultural aircraft, for civil and military tasks, and air survey work.

• **Preliminary work on an atomic-powered aircraft** has now been completed, according to official reports from Moscow. Crew compartments will be shielded by boral sheets (boron carbide and aluminium) and organic substances impregnated with boron particles. Lead sheet is used for protection against gamma rays.

• **An International Air Show** combined with a static display to illustrate the latest developments in aircraft manufacture will be held at Basle-Mulhouse Airport on September 6th/7th. The following countries have announced their intention to participate : USA, the United Kingdom, Canada, Sweden, Italy and Switzerland.

From the Farnborough Catalogue

• **British Insulated Callender's Cables Limited :** "Uni-efglas" cables for airborne installation, are rated for continuous operation up to a maximum temperature of 240°C and will remain flexible down to —75°C ; R.F. cables with moulded connectors ; sub-miniature coaxial R.F. cables ; polypole coupler systems ; "Tersil" cables for operating temperatures between —55°C and 190°C (capable of functioning for a period of five minutes at 1,100°C) ; thermocouple cables, etc.

• **British Timken Limited :** A wide variety of roller bearings for aircraft manufacture.

• **CIBA (A.R.L.) Limited :** Examples of the use of "Redux" bonding, "Aeroweb" metal honeycomb, and "Araldite" epoxy resins.

• **Cossor Communications Company Limited :** Fixed and mobile VHF and HF transmitters and receivers.

• **Cossor Instruments Limited :** Single beam and double beam oscillographs for a wide variety of uses.

• **Cossor Radar & Electronics Limited :** CR.787 and CR.21 surveillance radar with Moving Target Indicator and circular polarization ; SSR.1251 airborne transponder for secondary surveillance radar ; CRD.23 interscan display system for keeping track of identified aircraft ; special components used in radar and other electronic equipment.

• **Decca Navigator Company Limited :** Mark 10 Decca Navigator and other Decca components, including the latest types of Flight Log ; Dectra receiver ; DIAN (Decca Integrated Airborne Navigator, i.e., Decca plus Doppler) ; Decca and Dectra charts, etc.

• **Decca Radar Limited :** The new DASR. 1 long range civil surveillance radar ; Decca interscan display, on which other facilities in addition to radar information can be shown ; meteorological radar.

• **Delaney Gallay Limited :** Heat exchangers of aluminium alloy or stainless steel ; insulation blankets, etc.

• **Ekco Electronics Limited :** Type E 117 machine tool control with punched-card information storage system ; Type E 160 airborne search radar ; Ekco airfield approach aid providing talk-down facilities.

• **Elliott Brothers (London) Limited :** Airborne instruments ; automatic flight control systems ; fuel flowmeters ; automatic guidance and control systems for unmanned vehicles ; electronic test equipment ; navigational aids ; UHF communications equipment ; instrument landing systems ; radio telephone systems, etc.

• **Ferranti Limited :** Complete ground and airborne radar fire control systems ; gyroscopes ; gyro gunsights ; electronic machine tool control ; electro-hydraulic control valves ; turn accelerometers ; horizon gyro unit ; vertical reference gyro with synchros and potentiometers ; transformer rectifier unit ; electronic computers ; cathode ray tubes ; printed circuits ; silicon rectifiers ; ceramic-to-metal seals, etc.

• **Firestone Tyre & Rubber Company Limited :** Aircraft tyres.

• **P. Frankenstein & Sons (Manchester) Limited :** Beaufort 26-seat airline dinghy of neoprene-proofed Terylene fabric ; lifejackets ; baby's floating survival cots.

• **Graviner Manufacturing Company Limited :** Fire-warning and fire extinguishing equipment for aircraft ; industrial thermostats ; inertia switches ; explosion protection equipment ; temperature regulators.

• **Heenan & Froude Limited :** Engine test beds.

• **Integral Limited :** Hydraulic power packs ; hydraulic pumps ; special valves ; hydraulic motor-pumps ; four-channel rate-of-flow selector.

• **Irving Air Chute of Great Britain Limited :** Barometric sequence switches for parachutes ; electric and electro-mechanical cord cutters ; parachute recovery system for guided missiles ; aircraft landing brake parachute ; automatic parachute ground disconnect.

• **Latex Upholstery Limited :** Passenger emergency escape chutes ; "Kargo Pak" passenger cabin freight container ; passenger safety belts ; "Kargo" slides ; cabin furnishing ; passenger chairs ; lightweight upholstery fillings, etc.

• **Marconi's Wireless Telegraph Company Limited :** AD2300 Doppler navigator ; S264 surveillance radar (50-cm) ; SNW51 storm-warning radar ; Civil Aviation Data Handling system ; airways control console ; future position indicator ; PPI displays with superimposed D/F information ; automatic fixer equipment for use with VHF direction finders, e.g., Type AD200 or AD210 ; AD308 transistorized airborne teletype receiver ; AD712 automatic direction finder and AD722 sub-miniature automatic direction finder ; VOR/ILS receiving equipment, consisting of AD704 VHF receiver, AD706 glide slope receiver and AD708 marker receiver ; selective calling system, etc.

• **Martin Baker Aircraft Company Limited :** Ejection seats.

• **Mullard Limited :** Electronic components and equipment, radio and navigation equipment.

• **Murphy Radio Limited :** MR310/T miniaturized all-transistor passenger announcement equipment with an output of 40 watts and a weight of approx. 8 lb. ; MR380 airborne tape reproducer which enables background music to be played over the passenger announcement equipment ; Rebecca 8F, new version of the Rebecca 8 equipment ; MR347 transportable radar beacon for use in conjunction with the Rebecca 8F ; ground and airborne communications equipment.

• **Plannair Limited :** Axial flow blowers ; multi-stage compressors ; air heaters and air coolers.

• **Sperry Gyroscope Company Limited :** Aircraft instruments ; automatic controls ; hydraulic equipment ; "Introview" flaw detector for non-destructive testing of non-ferrous tubes, built under I.C.I. licence.

• **Standard Telephones & Cables Limited :** STR.23/34/35/36 comprehensive VHF/ILS/VOR airborne communication and navigation equipment, consisting of ST.23 transmitter (360 channels, VHF), SR.23 receiver (560 channels, VHF), 100-channel SR.34 VOR/ILS localizer receiver, 20-channel SR.35 glide path receiver and SR.36 75 Mc/s marker receiver ; frequency modulated sub-miniature transistorized radio altimeter ; transistorized 4-channel MF airborne radio teleprinter ; STR.18C/1 100-channel pilot-controlled HF communication equipment ; STR.9Z 44-channel VHF airborne communication equipment ; STR.12D 140-channel communication equipment ; SR.32/33 100-channel combined ILS/VOR airborne navigation equipment ; Commutated Antenna Direction Finder in air transportable container ; components for the "STRAD" telegraph retransmission systems ; components for the Stantec Zebra electronic digital computer ; electronic components, etc.

• **Teddington Aircraft Controls Limited :** Temperature controllers ; ice detection equipment ; time switches for de-icing, engine starters, navigation lights, etc. ; valves for fuel tank pressurization ; pneumatic pressure regulators.

JET-PROP BRITANNIA

now flying 2 million miles a month on world air routes

Flight crews, aero-engineers, operators, travellers, all acclaim the Britannia's remarkable record

The Britannia's impressive capabilities are being consistently demonstrated on world-wide routes.

Flight crews have expressed their great confidence in the Britannia. Airline engineers have praised the reliability of its Proteus jet-props. Operators have been impressed by its immense versatility and exceptional operational economy. Passengers have welcomed the speed, luxury, and smooth, quiet comfort of Britannia travel.

World-wide service by Britannia. Today, Britannias are flying more than two million miles a month, serving five continents with Canadian Pacific Airlines, BOAC, El Al Israel Airlines, and Aeronaves de Mexico.

Further Britannias have been ordered by Cubana de Aviacion, Hunting-Clan Air Transport, the Ministry of Supply, and the Royal Air Force.

A remarkable record. Britannias hold many commercial air records. They have broken transatlantic speed records no less than eight times. They have clipped hours off scheduled flights on trans-oceanic, trans-continental and inter-city routes.

Equally spectacular to aero-engineers has been the record of the Proteus jet-props. The overhaul life of the Proteus 705 reached 1,300 hours within 13 months of airline operation—the most rapid extension in aviation history.

All in all, the Britannia's in-service record has proved a great triumph, acknowledged by flight crews, aero-engineers, operators, and travellers throughout the world.

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Revolutionary Simplicity in New **Skid Warning System** by **Goodyear**

Taps Pilot's Foot—he maintains full control over braking at all times

Now Goodyear has engineered a Skid Warning System* which (1) automatically senses an impending skid *before it occurs*, (2) *warns the pilot*, and, (3) for the first time in such systems, *allows the pilot to maintain full control and full "feel" of his corrective braking!*

The moment rotation of any wheel begins to drop at an abnormal rate, a tiny sensing device on the wheel hub actuates a small pulsating button mounted on the brake pedal. *This button literally "taps" the pilot's foot and tells him to "ease up" his brake pressure.*

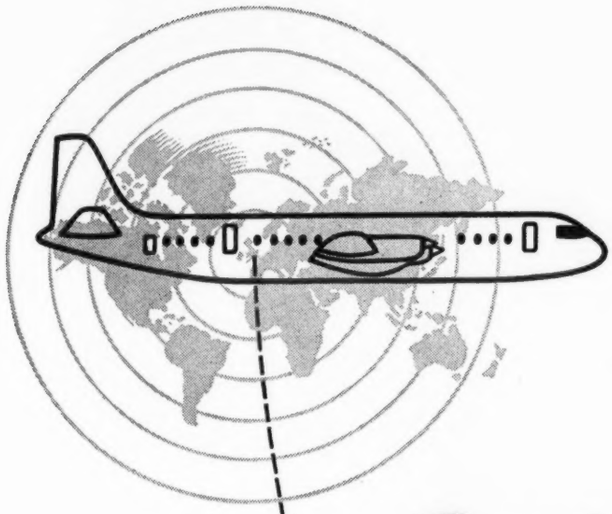
As a result, the pilot keeps full command of his aircraft, he himself makes the corrective action—virtually eliminating the veering, flat-spotting of tires and wheel-locking formerly caused by inadvertent over-braking. Maximum safe braking is maintained and landing runs substantially decreased.

Standout feature of the new system is its simplicity. No brake modification is required. The Goodyear System can be installed easily on any type brake or brake system. FOR COMPLETE INFORMATION on this revolutionary development for greater landing safety, WRITE: Goodyear International Corporation, Aviation Products Dept., Akron 16, Ohio, U.S.A., or The Goodyear Tyre & Rubber Company (Great Britain) Ltd., Wolverhampton, England.

*Patents pending

GOODYEAR AVIATION PRODUCTS

More aircraft land on Goodyear Tires, Wheels and Brakes than on any other make



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TRANSISTORS

The Standard S.T.R.23/34/35/36 equipment has been specified by **BRITISH EUROPEAN AIRWAYS** for their Vanguard and Comet fleets

* ST. 23 TRANSMITTER. 360 channels, 50 kc/s channel spacing, in the band 118—135.95 Mc/s. 20 watts telephony.
* SR. 23 RECEIVER 560 channels, 50 kc/s channel spacing, in the band 108—135.95 Mc/s. All spurious responses at least 90 db down.
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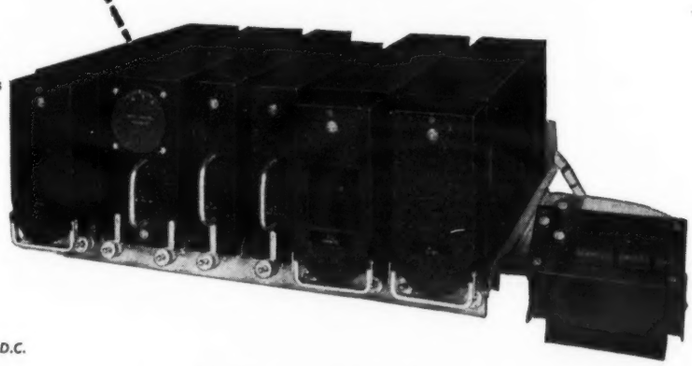
Operates from 115 Volts, 400 c/s, single phase A.C. or 28 Volts D.C.



Approx. half the weight, half the size, and half the power consumption of equipment it replaces!

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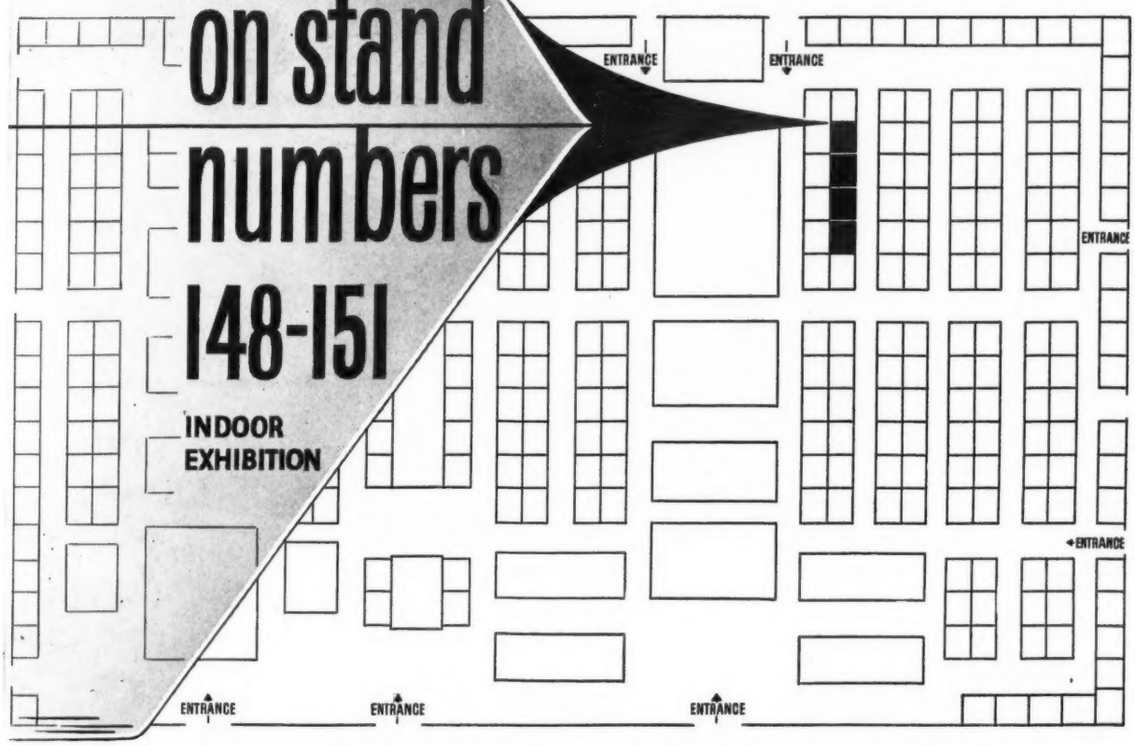

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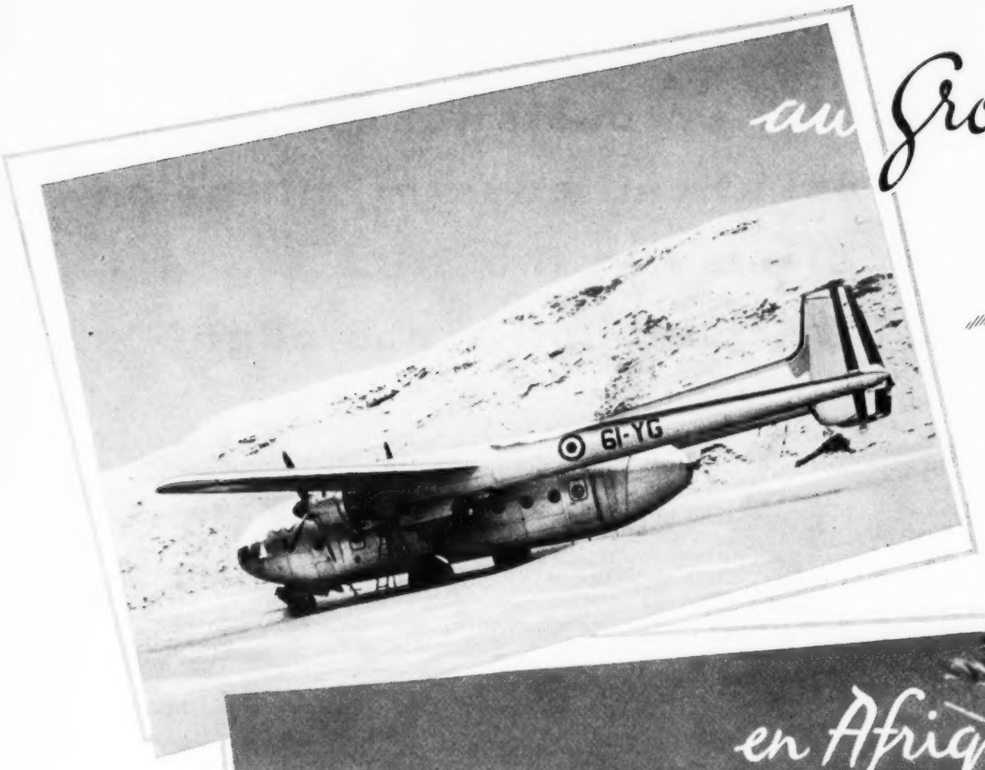

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1958 1st place Mr. Biancotto/France
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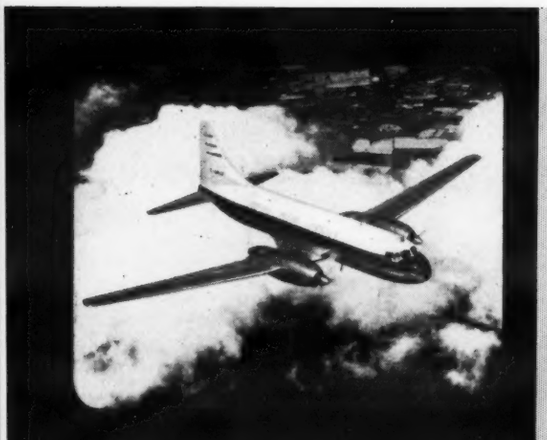
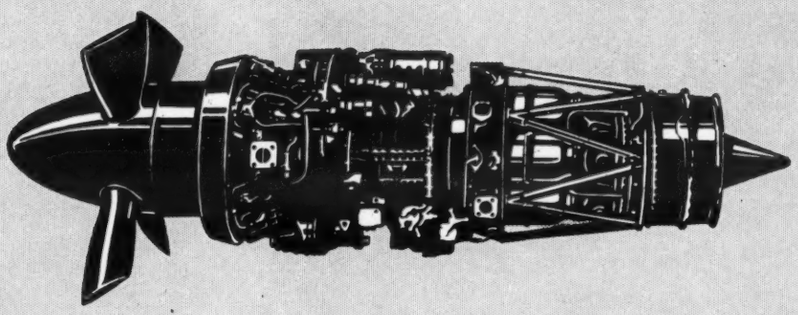
NAPIER

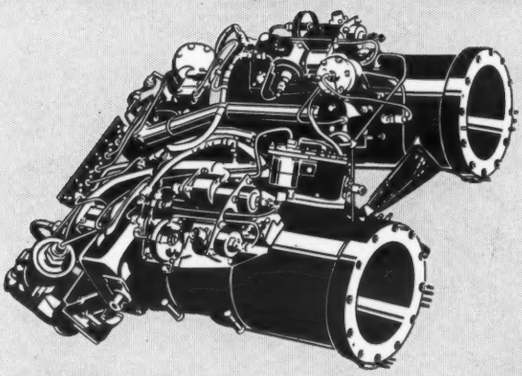
ENGINES MAKE NEWS

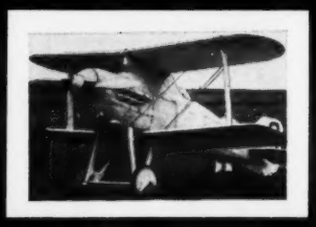




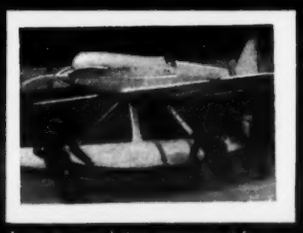
ELAND N. El. 3

Designed for rotary wing aircraft and powers the Fairey Rotodyne V.T.O. airliner, right, providing power for forward flight and compressed air to the rotor tip combustion jets for vertical flight. Another version of the Eland, the 229, powers the twin-engined Westland Westminster helicopter, left.





Lion powered Gloster 'Mars I'
Winner Aerial Derby, 1921, 1923



Lion powered Supermarine S.5
Winner Schneider Trophy, 1927

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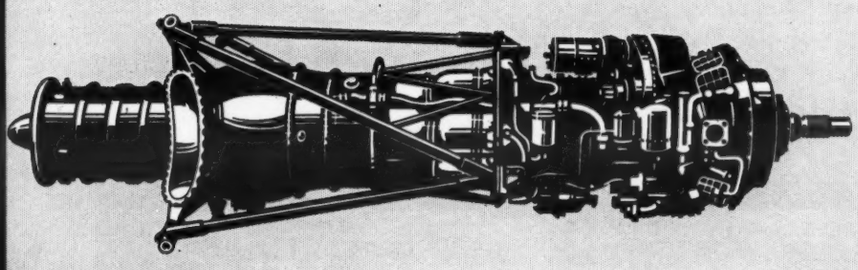
Rapier powered Short 'Mercury'
Long Distance Seaplane Record, 1938

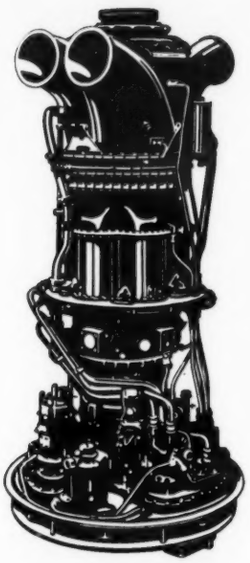
Typhoon, fitted with the "Sabre",
World's most powerful
piston aero-engine, 1941

Double Scorpion Canberra
World Aeroplane Altitude Record, 1957

ELAND N. EI. 6

Single shaft turbo-prop aircraft power unit of exceptional operational stability and safety for the Canadair 540, left, and piston-engined aircraft conversion.





GAZELLE

Free turbine engine for helicopters—e.g. the Westland Wessex below—with compressor and fuel metering systems designed for automatic peak efficiency at all power settings. The Gazelle also powers the Bristol 192 helicopter for the R.A.F.

DOUBLE SCORPION

Aircraft rocket engine for continuous operations providing repeated Start/Stop sequences at all altitudes. To be fitted in the English Electric P.1B., left.

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Speed Increase At Same Horsepower

Pays for itself in 1,000 hours by increasing range and payload with no increase in horsepower . . . flight performance and safety improved considerably. These are the findings of the many DC3/C47 owners who have purchased the lightweight, fully CAA approved AiResearch Maximizer Kit.

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KIT:

Scientifically contoured baffles with interrelated Engine cowl modifications

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Diffuser entrance fairing for oil cooler

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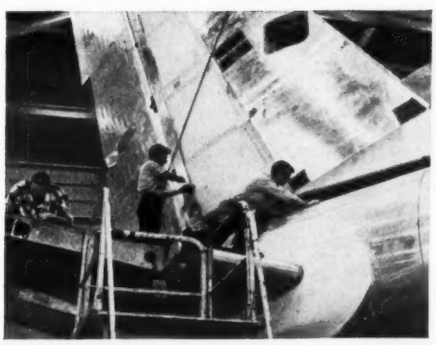
REPORT ON PRODUCTION

AHEAD-OF-SCHEDULE production of Boeing 707 jetliners reflects the efficient manufacturing techniques developed by Boeing while producing more than 1600 large multi-jet aircraft ... more than any other company in the world. Boeing methods, superior design experience and new facilities combine to produce outstanding jet aircraft. Boeing KC-135 jet transport-tankers, built in this same plant, are setting U. S. A. F. records for minimum maintenance and maximum reliability.

SUB-ASSEMBLIES completed in a huge new Transport Division facility are fed into final assembly area. In every phase of production, unyielding standards of quality control are adhered to rigidly. Incorporated in the 707, and the shorter-range 720, are all the benefits of Boeing's 10 years of multi-jet production experience.



INFINITE CARE assures assembly and production at the same high level as advanced Boeing design. Every step, every detail, is checked, double-checked, and checked again.

SLEEK 707s ROLL OUT AHEAD OF SCHEDULE. Within months they'll enter commercial service. By that time, Boeing multi-jet transport-type aircraft will have logged more than 200,000 hours of flight experience. The 707 and 720 will provide airlines with a family of jetliners loaded with passenger appeal, and designed and built for profitable operations on short, medium and long-range routes.

These airlines already have ordered Boeing 707 or 720 jetliners:

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The aircraft electrical power systems of tomorrow are already in the air—thanks to ENGLISH ELECTRIC. Nobody any longer doubts that Constant Frequency A.C. is the electrical power system for large aircraft of the future. Nor can there be much question that the system of choice is the system that has already logged tens of thousands of flying hours in hundreds of modern multi-jet aircraft—the system based on the Sundstrand Alternator Drive Unit.

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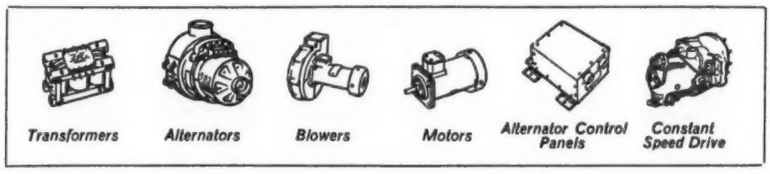

The General Motors Matched Power Team of Allison Prop-Jet Engines and Aeroproducts Turbo-Propellers Brings Flight-Proved Jet-Age Power to Airlines of the World in The New Lockheed Electra

FOURTEEN AIRLINES CHOOSE ALLISON PROP-JET POWER. The flexibility of Allison Prop-Jet power enables the Lockheed Electra to solve major problems facing the airline transportation industry—bringing jet-age speeds, comfort and economy to flights of *all* ranges. The Electra, with its four Allison Prop-Jet engines and Aeroproducts Turbo-propellers developing a total of 15,000 horsepower, can operate from existing airports *quietly* and *efficiently* under present air traffic control patterns. A total of 151 Electras has been ordered by 14 airlines—a demonstration of their confidence in the ability of this luxurious airliner to fulfill its mission for air travelers everywhere.

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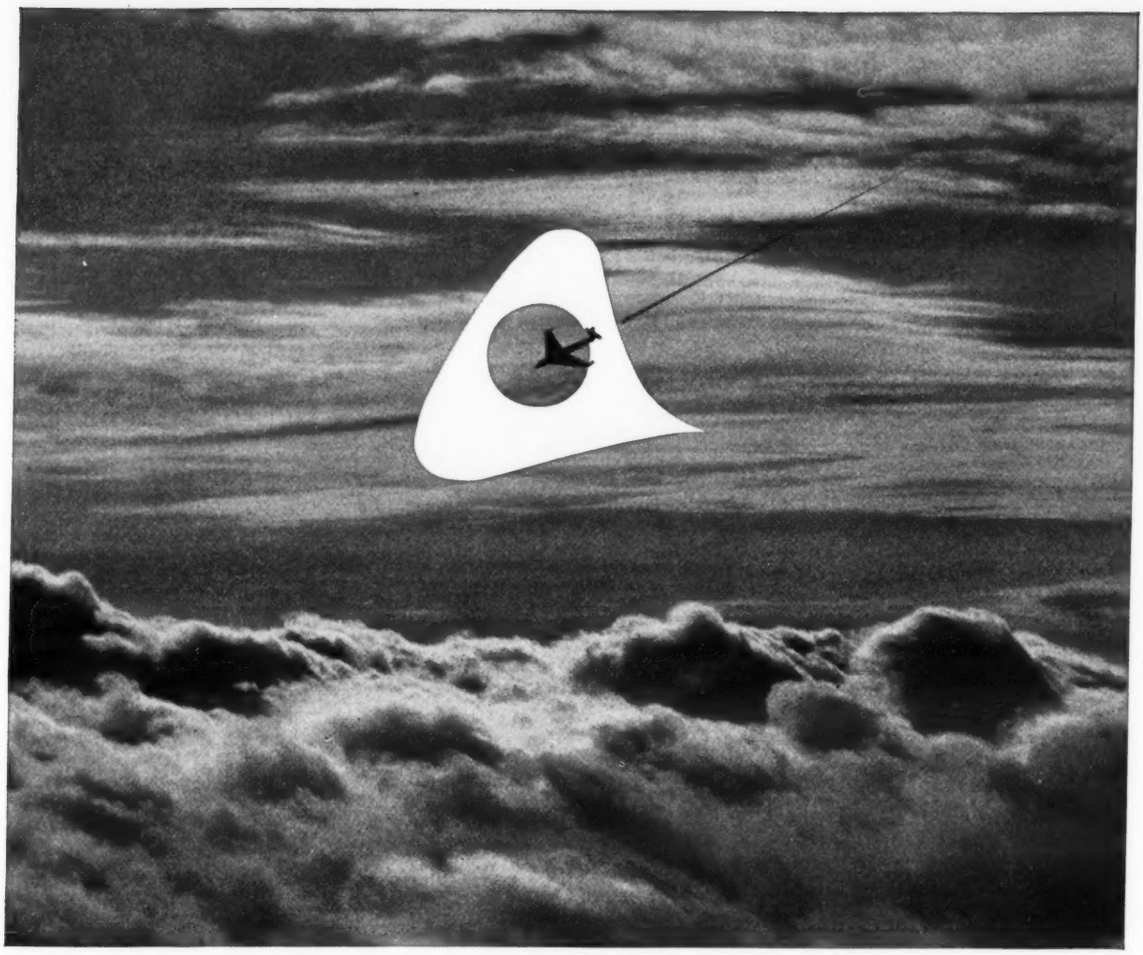

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VIPER

Powers World's First All-Through Jet Trainer

The Hunting Provost

The decision of the Royal Air Force early in 1957 to pioneer 'all-through' jet training was made possible mainly by one fact; that there was in existence an aircraft and an engine which exactly met their requirements for the job — the Hunting Jet Provost powered by the Armstrong Siddeley Viper. Apart from the logic of 'all-through' jet training for jet age pilots, economy was an important factor in this new policy: and on this score the Viper's record passed service scrutiny with flying colours. Here was an engine with a really high utilization rate—reliable, robust and easily serviceable. Today, Jet Provosts, powered by the Viper Mark 8 are now serving with the R.A.F.; their record under training conditions has been beyond reproach.

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The U.S. Local Service Airline System

In the August issue of Interavia *(No. 8, 1958), James Durfee, Chairman of the Civil Aeronautics Board, pointed out the growing importance of local air services in the country's economic life. He added that the U.S. authorities plan to spend some $40,000,000 on expansion of the local service network this year. As this branch of air transport is less generally known, it is treated in somewhat greater detail below.* Editors.

The development of the U. S. local service airline system is regarded as one of the most remarkable records in the history of American commercial aviation.

Created at the close of World War II to extend the advantages of regular air service to the small and intermediate cities, the nation's 13 local service airlines today serve all but four of the 49 states. Some 270 of the 460 cities they serve depend entirely upon local service airlines for their only scheduled air passenger, mail and cargo service.

Transferring onto a trunk airline flight at a major terminal, a person can now depart on a local airline flight in the morning and arrive at practically any U.S. city by nightfall. Europe is at most a day and a half away from the most remote areas served by local airlines.

Beginning with a handful of aircraft operating over limited route patterns, they now operate some 225 twin-engine transports, flying 185,000 miles a day over 25,500 miles of routes. Last year, close to four million people chose to fly on America's local service airlines. This is about twice the 1953 volume—or about nine times the volume in 1948. Last year 1.5 million ton-miles of mail were airlifted by the local airlines—four and a half times that of 1948. Air express and freight volume was 3.7 million ton-miles—an eight-fold gain.

The local airlines are an essential, integral part of America's total airline system. As a major extension of the overall service, they all observe the same high standards of aircraft maintenance and flight operational safety. And any of the domestic scheduled airlines—trunk or local service—will make the complete arrangements for a passenger's entire trip. All he needs is one reservation, one ticket, one baggage check for any U. S. destination.

The local airlines participate in joint interline fare structures with the trunk airlines ; they observe industry "Family Days" when "Dad goes full fare and Mom and the kids go half-fare". They participate in the Universal Air Travel Plan.

The amazing growth of the local airlines and their outstanding performance of public service have been achieved despite serious handicaps. The industry began, for the most part, on limited funds. The cities were mostly small ; their airports were small. They were an average of less than 70 miles apart ; there were no federal airways. And it is probably correct to say that the people were, by and large, strangers to the travel-by-air habit.

And if that is not enough, it is a well-known fact that in the airline business, competition from surface transportation—primarily the private automobile—is more intensive in the short-haul market.

The local airlines also faced the higher costs of short-haul operations. An airport station must be equipped and staffed on an average of less than 70 miles. This means, further, that aircraft are operating at maximum power more of the time—as many as 32 or more airport operations per aircraft every day. It means also that the passenger flies only about 190 miles on an average local airline trip, and the airline receives only $12 revenue per passenger. Yet it costs as much to board a passenger for a short flight as for a long trip.

It was obvious that such an operation could not be sustained solely on a commercial basis initially, that the cities could not produce enough passenger and cargo business to make the service self-sufficient for some time to come. Thus, partial government aid, in the form of " public service revenues ", was necessary to help support the service until the cities could pay their own way.

Dependence on public service revenues has declined steadily as the result of aggressive traffic development and sharp gains in efficiency. The local service airlines have, for example, quadrupled the number of passengers boarded per station since 1948. Passenger load factor has gone up from 27.4 percent in 1948 to 45.7 percent for the year 1957. And despite spiralling costs in all categories of operation, local airlines have held expenses per available seat-mile down to a slight rise of only two percent in 10 years. As a result, the percentage of public service revenues to total revenues has shrunk from 75 percent in fiscal 1948 down to 34 percent today.

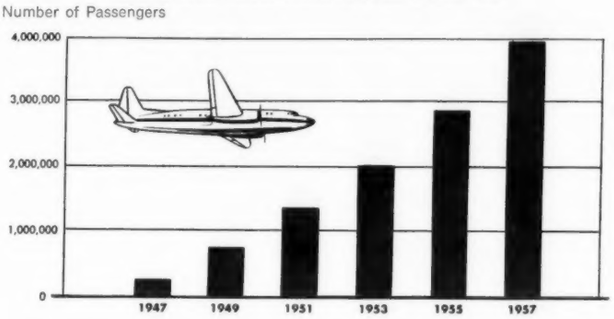
Since further decline in public service revenues is becoming increasingly difficult with the DC-3, the local airlines are making every effort to re-equip. While the DC-3 has been a safe, dependable aircraft, it has never been economical for local service.

The carriers are counting on new aircraft for greater loads at less cost per seat-mile. They are also banking on the sales advantage that new planes will bring.

Three of the 13 local airlines are already supplementing their DC-3s with Martin 202s or Convairs. Four others have placed orders for the F-27 being manufactured by Fairchild Aircraft in Hagerstown, Md. The remainder are still searching for the aircraft that will best suit the characteristics of their region and operation. It is not an easy decision, because each airline has different operating problems.

Aggressive in traffic development, the local airlines assert that a new airplane will give them a new sales tool to go out after the short-haul market with even greater vigour.

U. S. LOCAL SERVICE AIRLINE PASSENGER TRAFFIC INCREASED MORE THAN 16-FOLD SINCE 1947



When originally certificated by the Civil Aeronautics Board, it was anticipated that their main function would be to " feed " the long-haul trunklines. They quickly outgrew their " feeder " status, however, as they began to develop traffic within their own routes.

Results of a study made recently by one of the local carriers points up the opportunity inherent in the U.S. short-haul travel market. The airline reported that in 1949 about 65 percent of its traffic was " feeder " or interline. Today the opposite is true. The airline says 69 percent of its traffic is one-line—between points within its own system.

This local traffic, the airline reports, is made up of increasing commuter and commercial travel between intermediate cities and marketing centres.

The airline concluded that while the local airline industry's volume of four million passengers in 1957 testifies to the ability of the local service airlines and the communities to generate short-haul traffic, it represents only a fraction of the full potential of the market.

The " Cinderella of the Brussels Fair "

In publishing the article on the Brussels Fair in Number 7, 1958, the Editors were well aware that all readers may not have shared the author's impressions. In fact at the end of the article it was stated that Interavia's *editorial columns are open to all those who disagree. The first letter on this subject has been received from Lieutenant-General Baron Wahis, Honorary President of the Aviation Department at the Brussels Fair.* — Editors.

" The article with its interesting illustrations attacks without malice not the Transport Pavilion, but the treatment given to aviation at the Fair as a whole.

" These criticisms, however, are not very relevant. The author has not freed himself from the specialist's point of view as applied in assessing the Paris Air Show, and he has not been able to understand the universal and international character of the Fair. It is easy to describe it in a condescending sense as a " huge bazaar ", but this is not quite correct.

" *Interavia's* Special Correspondent could easily have found out that every one of the participating Nations had full liberty to arrange its exhibition as it wished, both as regards the objects chosen and the method of display.

" This liberty is, of course, incompatible with any kind of enforced programme. But when the Fair is over, the " Cinderella " will find its glass slipper and its true place in the development of human achievement. Wahis. »

INTERNATIONAL MEETINGS AND CONFERENCES

Sept. 1st-7th : SBAC — 19th Flying Display and Exhibition. Farnborough.

Sept. 1st-14th : International exhibition "Atoms for Peace". Geneva.

Sept. 1st-15th : RAS 6th International Aeronautical Conference. Folkestone and London.

Sept. 3rd-23rd : Assembly of the World Meteorological Organization. Geneva.

Sept. 4th-6th : AGARD — Avionics Panel Meeting. Cambridge, England.

Sept. 6th-7th : International Air Show Basle. Basle-Mulhouse Airport.

Sept. 6th-14th : First International Aviation Show ("Aviation Reports to the Nations"). New York.

Sept. 8th-13th : First International Congress, International Council of the Aeronautical Sciences. Madrid.

Sept. 8th-13th : IATA — 11th Technical Conference. Monte Carlo.

Sept. 15th-17th : Joint Meeting, Aviation Technical Service and Aviation Advisory Committees — American Petroleum Institute. Dallas, Texas.

Sept. 15th-18th : Fall Meeting, American Rocket Society. Detroit, Michigan.

Sept. 15th-20th : First conference of the international committee for aeronautical applications of sandwich construction and bonding. Madrid.

Sept. 19th-26th : 9th international radio, television and electronics exhibition. Amsterdam.

Sept. 22nd-24th : National Association of State Aviation Officials Meeting. Philadelphia, Pa.

Sept. 22nd-27th : National Business Aircraft Association, 11th Annual Meeting. Philadelphia, Pa.

Sept. 22nd-27th : AICMA — 3rd Aeronautical European Congress. Brussels.

Sept. 23rd : IATA — Composite and Joint Meeting of Traffic Conferences. Southern France or Italy.

Sept. 24th-25th : IRE/AIA/EIA — National Electronic Conference. Chicago.

Sept. 25th-27th : American Helicopter Society, 5th Annual Western Forum. Los Angeles.

Sept. 25th-27th : Air Force Association, Airpower Showcase. Dallas, Texas.

Sept. 27th-Oct. 7th : 8th International Engineering Show. Turin.

Sept. 28th-Oct. 1st : ASME — Power Conference. Boston.

Sept. 29th-Oct. 3rd : National Aeronautic Meeting, Society of Automotive Engineers. Los Angeles.

Oct. 1st-3rd : AAAE/CAA — National Airports Conference. Norman, Okla.

Oct. 7th-8th : CAI/IAS — Joint Meeting 1958, Canadian Aeronautical Institute, Institute of the Aeronautical Sciences. Ottawa.

Oct. 8th-11th : WGL — Annual Meeting of the Wissenschaftliche Gesellschaft für Luftfahrt. Stuttgart.

Oct. 9th-10th : 9th Annual Noise Abatement Symposium. Armour Research Foundation. Illinois Institute of Technology, Chicago.

Oct. 9th-10th : Fuels — ASME Conference. Old Point Comfort, Virginia.

New York Finance Notes

U.S. Aircraft Industry and Air Transportation in Mid-August 1958

BY SCOTT HERSHEY, NEW YORK

A buoyant market has added volume and dollar value to the Big Board list, lifting share prices to the highest average levels since August of last year with activities in securities generally reminiscent of bull market periods of the past.

Despite this, the list of most active stocks on the New York Stock Exchange day by day makes aviation securities conspicuous by their absence. As the year went into its eighth month, the aircrafts finally developed some strength, if minor gains can be dignified by narrow advances, and the experts rushed to say that a partial explanation was the fact that the aircraft group had been neglected in favour of steel and chemicals and copper, and of course, oils.

Those interested primarily in aviation securities had some cause for rejoicing when General Dynamics went up 2 ¼ on one of the best aviation days recently. Lockheed and Martin were both up a point and Chance Vought a half.

There was not much in first half and second quarter reports which began to come in to cheer about although there was good news for shareholders from *Lockheed*, in contrast to some other rather gloomy ones. Lockheed, for six months to June 30, had net income of $9,743,000 or $3.30 a share, an increase of 29 cents a share over the $7,570,000 or $2.65 a share in the period last year. Gross of $465.735,000 was the highest for any like period in the company's history and an increase of almost 10 percent over the $425,067,000 shown a year ago. The sales increased for the sixth consecutive six months period. There is not much there for Lockheed stockholders to complain about.

Republic Aviation reported net income of $1,528,697 or $1.04 a share on sales of $86,374,821 in the first half of this year. This is a decline from earnings of $3,665,749 or $2.49 a share on sales of $168,374,970 in the first half of last year.

At the same time, Republic made a significant announcement that the corporation is embarking upon a $35 million research and development programme in advanced airplanes, missiles and space vehicles. The programme will involve the construction of a $14 million engineering and research development centre at the company's Farmingdale, Long Island plant, and another $21 million will be used to operate the facility and conduct tests. The programme will be financed from the company's earnings and from existing credit relationships without recourse to sale of additional securities.

North American Aviation's net income for the nine months to June 30 was $18,233,000 equal to $2.27 per share, against $26,604,000 or $3.32 a share in the period of the preceding fiscal year. In the June quarter alone, net income was $5,342,000 or 67 cents a share, as compared with $8,122,000 or $1.01 a share in the 1957 period.

The report from *Douglas* was along similar lines for the six months to May 31, first half of the fiscal year. Net income was $12,645,000 or $3.41 a share against $16,674,000 or $4.50 a share a year ago. The company said the decline in earnings reflects a lower rate of deliveries of DC-6 and DC-7 commercial aircraft and write-offs on the DC-8 jet transport programme which amounted to $27,839,000 in the latest period.

Fairchild Engine and Airplane, which had a profit in 1957, expects to report a first half loss of about $5 million and foresees additional losses during the second half as a result of high costs in the development of its F-27 turboprop airliner.

In a letter to stockholders, Richard S. Boutelle, President, said the twin-engine F-27 "cost considerably more than anticipated" and that the company ran into "unforeseeable delays and problems" when it attempted to adapt its production methods to the Dutch drawings and designs obtained under licence from Fokker. However, Boutelle received a CAA certification at International Airport for the F-27 and noted this marked Fairchild's re-entry into the commercial field.

Fairchild already has reported a first quarter 1958 loss of $1,994,000. The company earned $432,000 or 14 cents a share in the first half of 1957, or 17 cents a share for the full year.

★

And in the *air transport field,* W. A. Patterson, President, United Air Lines, made his shareholders feel good by reporting that revenues in the second quarter soared to a record for the period and earnings nearly doubled the year earlier quarter despite a tax adjustment which trimmed net income.

While he said that earnings continue to provide inadequate returns on capital invested, the 6 ¼ percent fare increase effective in February and traffic gains in both freight and passenger miles contributed to the revenue and earnings pick-up. Profits for the first half year, including $138,371 from the sale of surplus aircraft, rose to $4,139,514 or $1.19 a share, from $2,953,192 or 91 cents a share, including $1,549,634 from sale of aircraft, a year ago.

United's operating revenue rose 11 percent to $148,073,637 from $132,055,366 a year ago, with passenger revenue up 11 percent, freight up 11.5 percent, mail up 8 percent and express up 4 percent. Operating expenses of $139,356,256 were up 8 percent.

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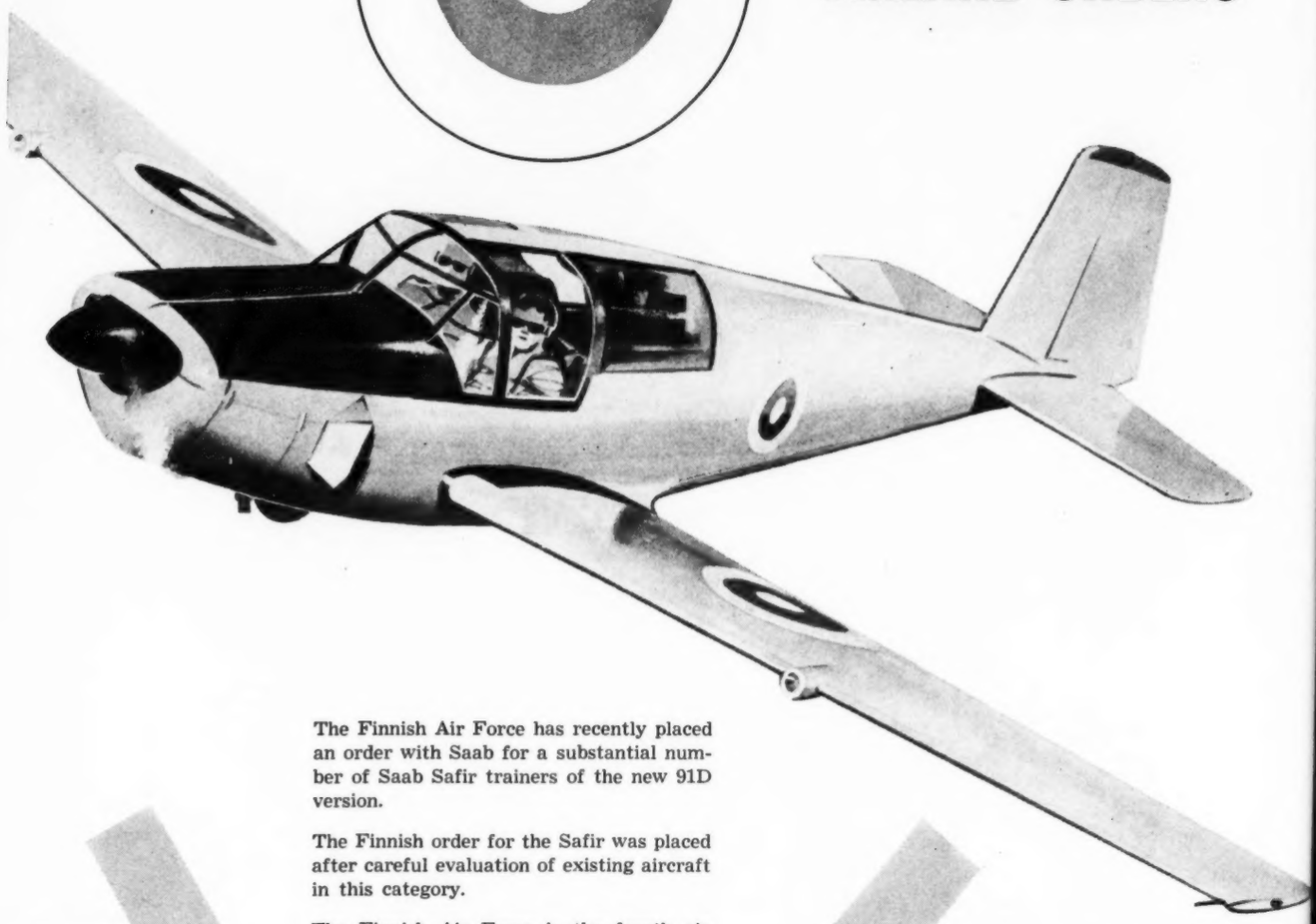


THE NEW SAAB SAFIR

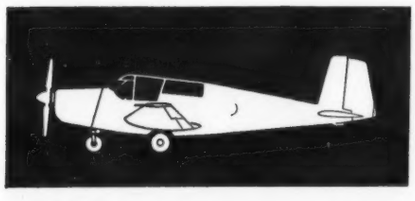
The Finnish Air Force has recently placed an order with Saab for a substantial number of Saab Safir trainers of the new 91D version.

The Finnish order for the Safir was placed after careful evaluation of existing aircraft in this category.

The Finnish Air Force is the fourth air force to acquire the Safir which is now in use in seventeen countries.

In addition to being one of the world's most economical military trainers up to the stage of advanced jet training, the Safir is also in widespread use for commercial pilot training.

Powered by the new and lighter Lycoming 0-360 four-cylinder engine, which permits the use of a constant-speed propeller and a more powerful generator (for extra electric and radio equipment), the 91 D can carry a greater useful load than its predecessors.



SAAB

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These illustrations show, actual size, some of the Timken tapered-roller bearings used in aircraft

From left to right, top row, these comprise

1 *Blade root bearing for variable-pitch propeller.*
2 *Bearing for an airborne instrument mounting.*
3 *Helicopter rotor torsion hinge bearing.*
4 *Bearing for spider mechanism controlling cyclic pitch of helicopter main blades.*

Bottom row, left to right:

5 *Bearing for variable-pitch propeller blade root, also for helicopter rotor torsion hinge.*
6 *Helicopter tail rotor blade root bearing.*
7 *Light section bearing used for many applications including helicopter blade hinges.*

Timken bearings can be supplied to meet widely differing requirements, for example, the steep angle bearings 1, 2, 3, 5 and 6 are designed to meet thrust loads heavy in proportion to the radial loads; 4, resisting tilting, is chiefly subjected to radial loads, so is example 7.

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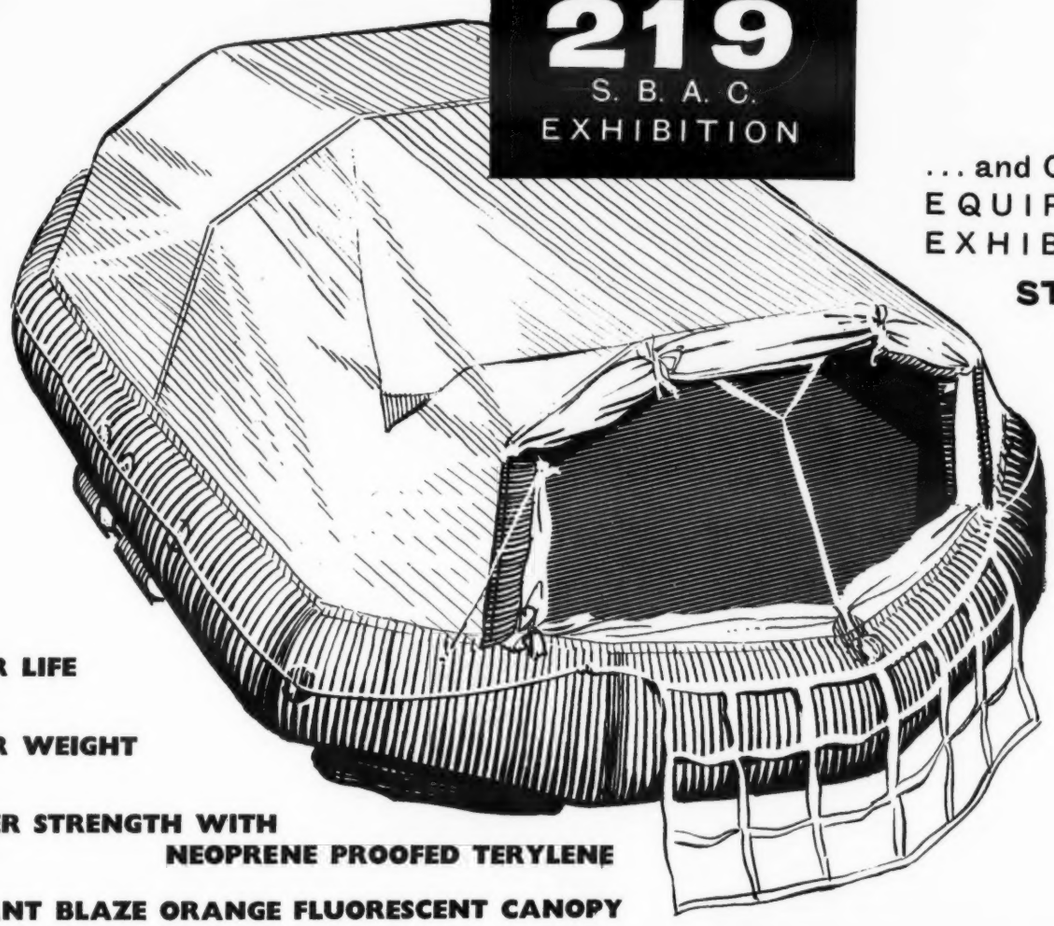

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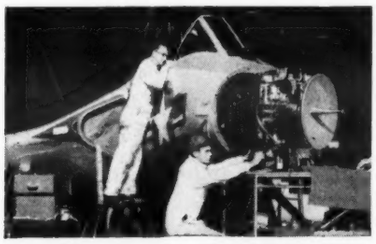
In the 6,000-lb. thrust class, the J-54 makes extensive use of titanium alloys to achieve its compact size, light weight and design simplicity. It has already passed successfully an unofficial 150-hour endurance test and initial flight tests in a B-45 flying test bed. In addition to having delivered completely stall-free performance over a broad operating range, the J-54 passed all engine light-off and jam acceleration tests.

Measuring only 35 inches in diameter and 10 feet in length, the J-54 offers operational flexibility, rugged but lightweight construction, and low operating costs. Write for detailed information and engineering data on this new axial-flow jet engine by Westinghouse.

If you'd like additional information on the developments shown here or help on specific aviation engineering problems, write to Westinghouse Electric International Company, Box 345, Wall Street Station, New York 5, U. S. A.

Aero 13 system finds, tracks, aims at target



There's little chance for unfriendly aircraft to escape from the Westinghouse Aero 13 airborne armament control system. This highly accurate system locates and tracks a target by radar. Then a computer automatically figures out the best attack course and supplies the pilot with firing data. Compact and lightweight, the complete Aero 13 system slides in and out of a jet's nose for fast, simple maintenance and replacement. Write for "Booklet 8-R."

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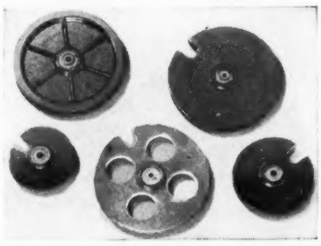

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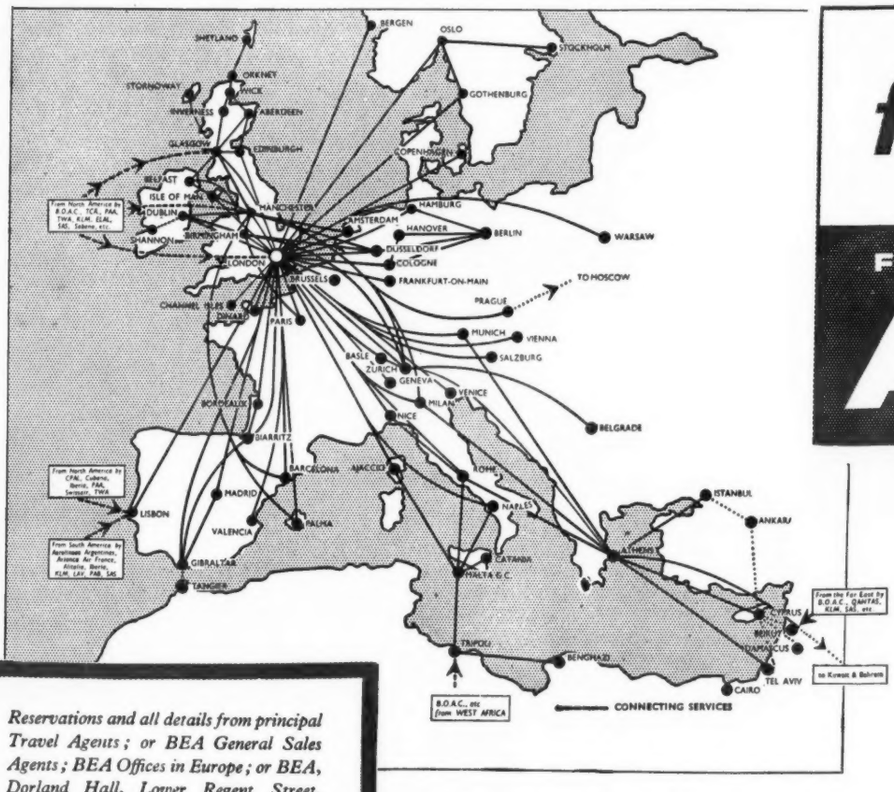

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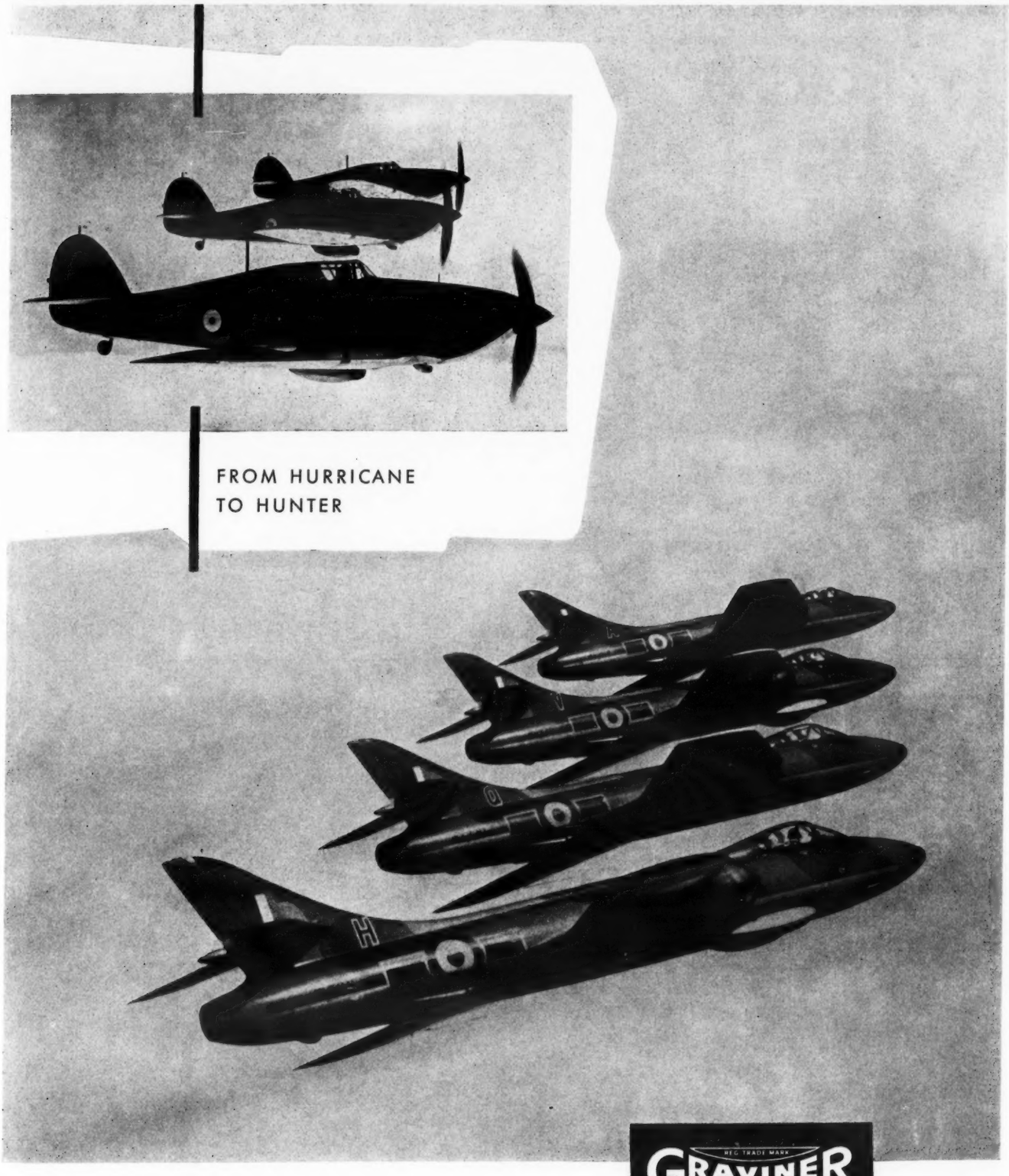

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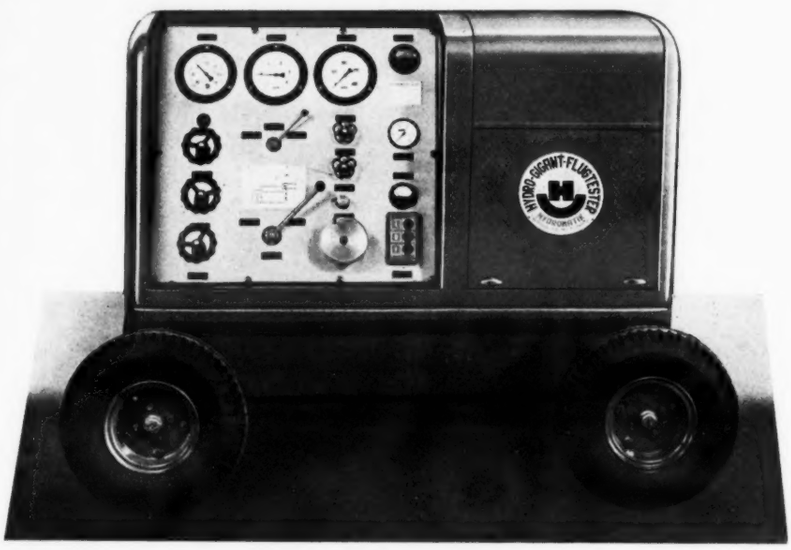

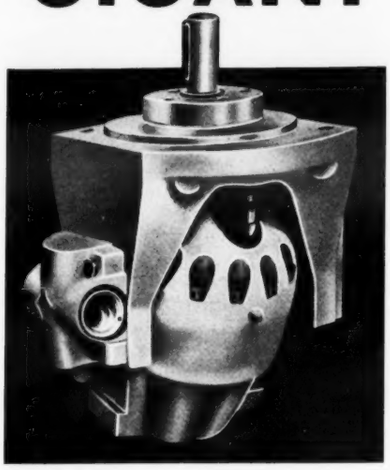

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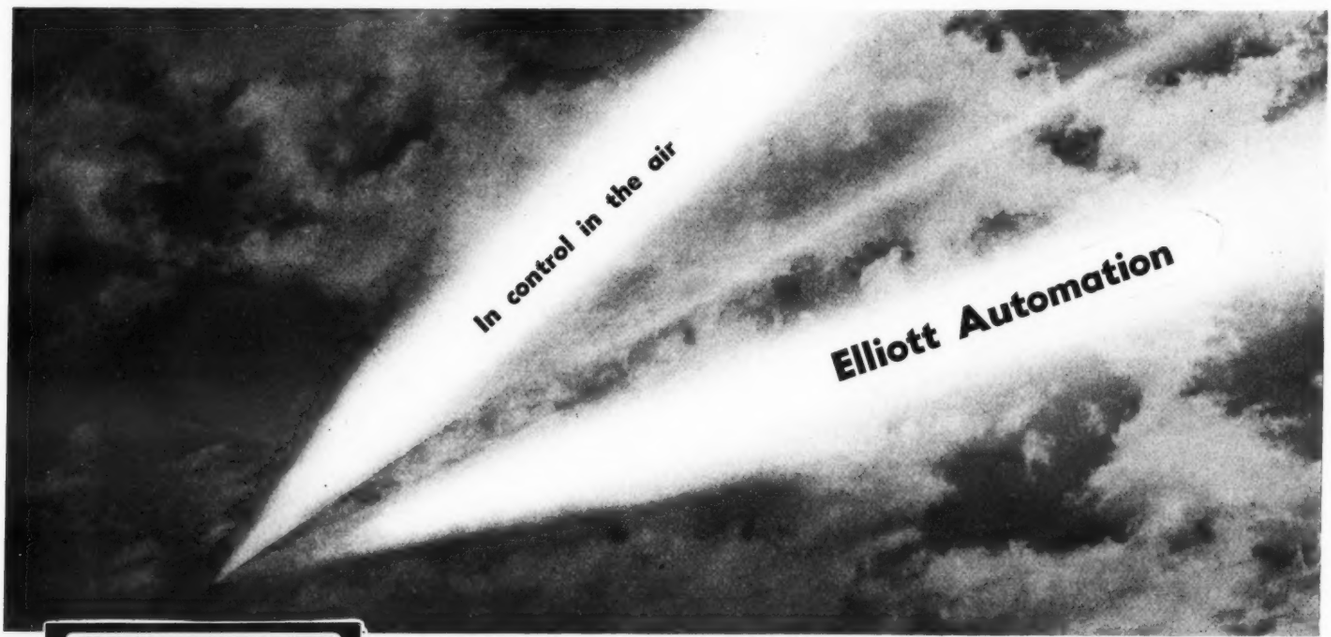

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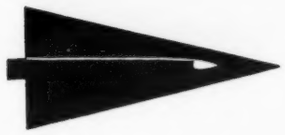

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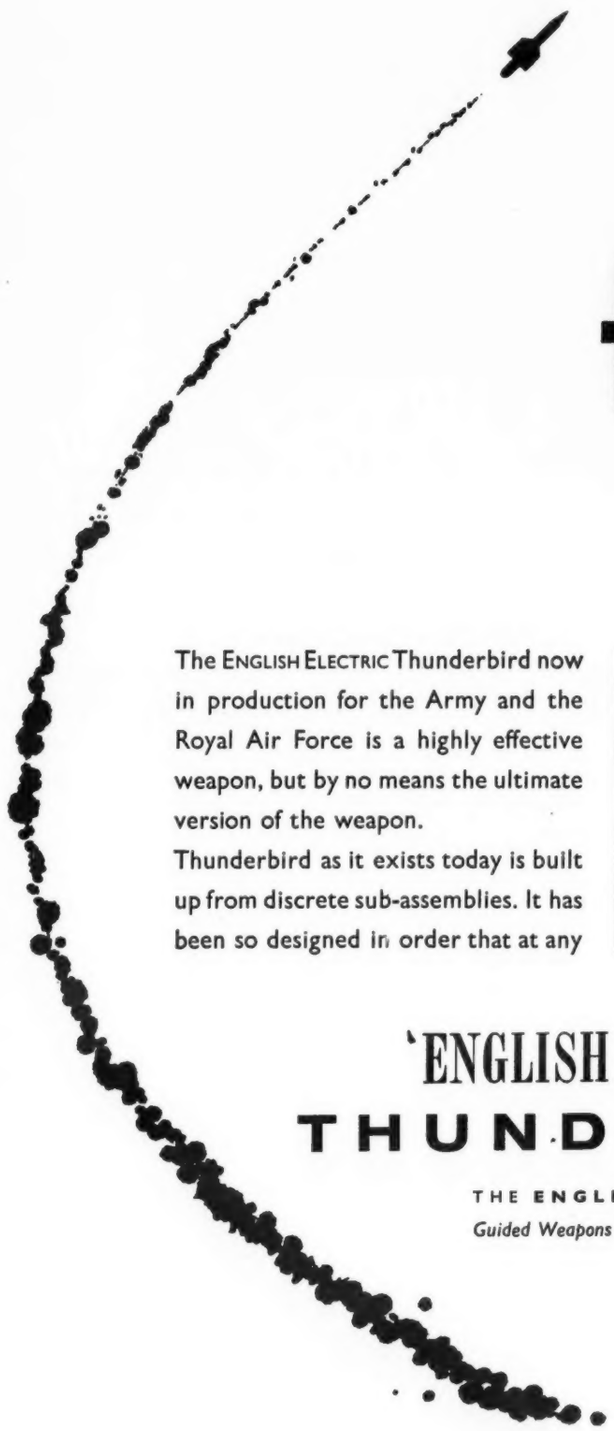

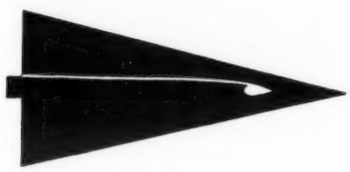

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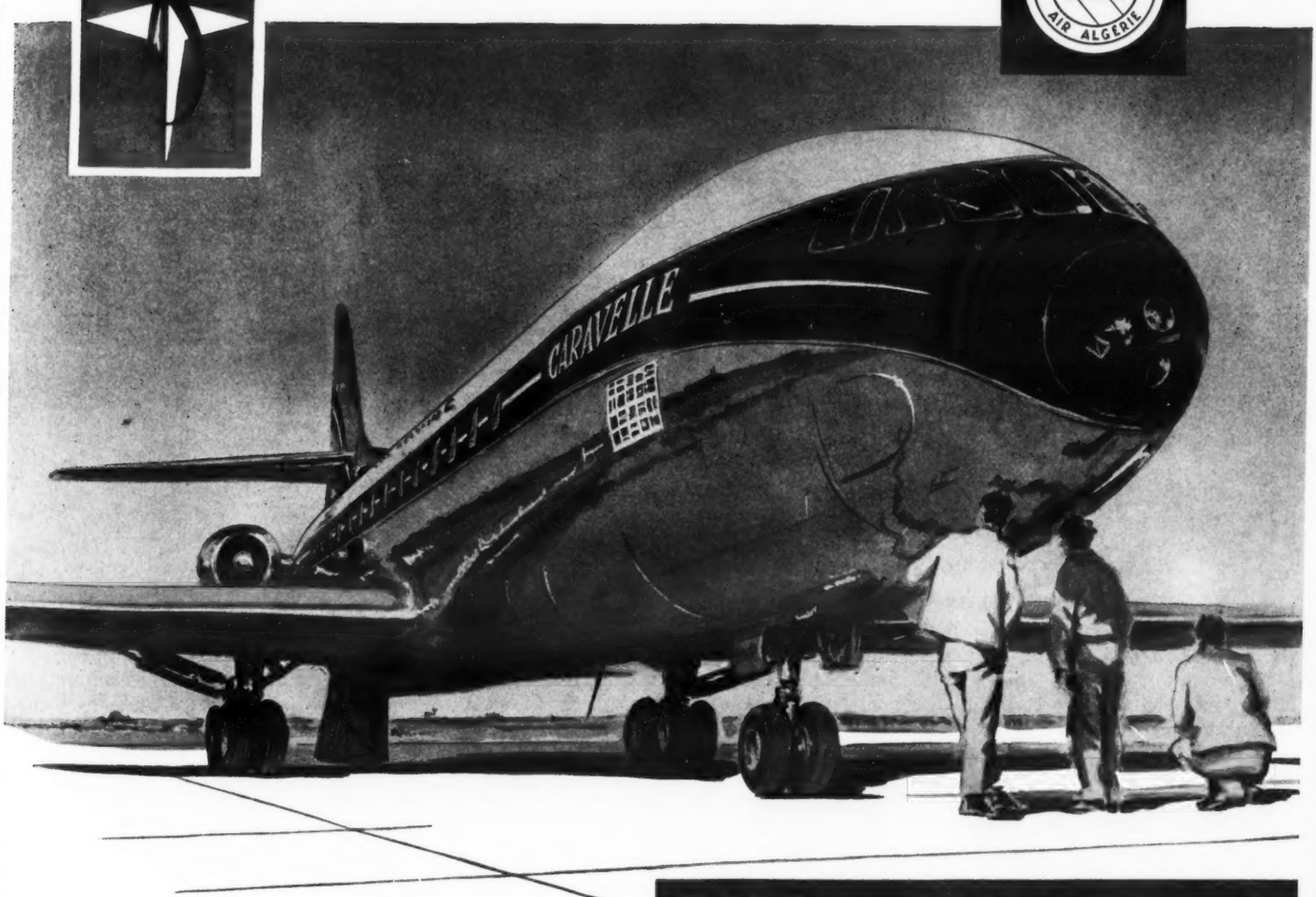

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Guided Weapon *by Roy Nockolds*

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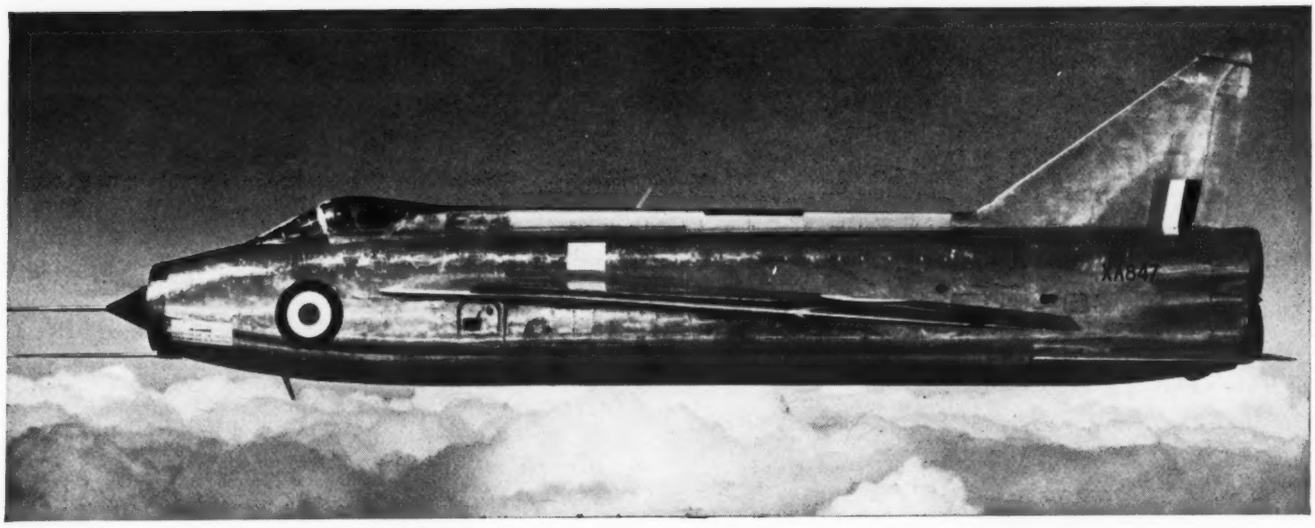

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Message to "Interavia"

From The Rt. Hon. Aubrey Jones, M. P., Minister of Supply

This special issue of *Interavia* for the Farnborough Display comes in the year of the publishers' 25th Anniversary. Congratulations are appropriate, not least on the contribution which this publication makes to the international spread of aeronautical knowledge.

It is also the 10th Anniversary of the formation of the North Atlantic Treaty Organization, the framework for the common defence of over 380 million people on both sides of the Atlantic.

Confronted with striking evidences of Russian technological progress, the allied nations have now, through cooperation within NATO, decided to build up their technical and scientific resources.

It is to this end that there has been so much discussion of late about interdependence, a concept to which we in Britain attach the highest importance.

The Display of the Society of British Aircraft Constructors at Farnborough shows something of the contribution which Britain can make to our common defence.

The British Aircraft Industry

The Future — From the Inside Looking Out...

By Derek Wood, London

There is no doubt that in the past twelve months the British aircraft industry has been going through one of the most difficult and complex periods in its history.

In every firm there has been a re-assessment of prospects and policies following the Sandys White Paper of 1957. At first it looked as if the bottom had dropped out of the manned aircraft market as far as the military were concerned, but little by little, the pendulum has been swinging back as weapon limitations have been realised, and skirmishes such as Aden and Cyprus have revealed lamentable gaps in manned armaments.

The pendulum is still swinging, but it is quite clear that while military aircraft production will continue and new machines will be developed, the total orders will be much smaller, and the number of individual types few.

The Government has decreed that firms must cooperate on new military contracts to provide stronger industrial groupings and where possible they recommend that firms should get into the civil market. On the face of it, this is sound, but when examined closely the idea has two major flaws.

Firstly, it is no use firms amalgamating or even getting together on some other basis unless it is to build something—it will, in the long term, only add one shop full of idle machines to another!

Secondly, many people in high political circles in the United Kingdom, particularly in the Treasury, imagine that the civil market is a golden apple only waiting to be plucked

The Royal Navy's Armstrong Whitworth (Hawker) *Sea Hawk* carrier-borne fighter and fighter-bomber. Aircraft of this type have also been delivered to the Royal Netherlands Navy and are in service with the West German fleet air arm.

from the tree, when in fact it is the most cut-throat business in the world with numerous firms trying to sell many types of aircraft to too few operators, the last mentioned in any case having very little money at this time to buy much.

Above all this, the British industry faces its greatest competition in the United States where the industry has a breakdown of 71 percent military aircraft, 78 percent military engines and 78 percent military propellers out of their present total aviation backlog of 14,000 million dollars (latest Aircraft Industry Association figures). Looming in the background also, is the spectre of the Soviet Union who can undercut anybody on price as they choose.

The effects of the Defence White Paper were in many cases salutary, as firms swept up with a new broom and took stock, but since then the Government have doggedly refused to say what and how many will be built in future. Spokesmen have confirmed that the aircraft industry is essential, and that research money will be continued etc., but in the face of the death of items like the SR.177 fighter, and the *Orion* turboprop—both at an advanced stage of development—the industry wonders whether any future project will ever get to or beyond the prototype stage.

At "Exercise Prospect 2", in May, Air Vice Marshal Kyle outlined the RAF's possible future requirements, which are as follows:

1. A combined low-altitude supersonic strike and fighter/reconnaissance aircraft for use in overseas theatres.
2. A light tactical strike replacement for the *Venom*.
3. A *Whirlwind*/*Sycamore* helicopter replacement.
4. A medium-range freight and passenger transport with a maximum range of 2,000 miles.
5. A long-range heavy transport with a range of 5,000 miles.

Further projects not mentioned were a *Shackleton* replacement for Coastal Command, and a VTO light strike machine, eventually to replace the present category (2) above.

All this, plus stage II ground-to-air weapons, the anti-ICBM missile, further stages of air-air weapons, and some Naval types, would seem to make the future look rosy indeed.

The plain fact of the matter is that no-one has yet indicated which types there will be money for, or how many of these good ideas will fade away on their drawing paper, or be dropped in mid-stream.

Anyone who imagines that *any* aircraft industry can ever live on private venture civil machines alone, or pay completely for its own research, is just not facing reality, because civil production and investment must run side by side with official orders and research if new ground is to be broken and any competitive price be quoted for export.

A firm schedule would allow Britain also to offer something tangible to NATO countries, in particular, France, Italy and Germany, and where necessary development and production could be pooled as has been the case with the Fiat G.91. In addition, it would ensure continuity in Europe's major aero-engine industry.

The ray of hope in recent weeks has been the inter-departmental committee which has been discussing aviation research and future policy. They have completed their investigation and, at the time of writing, an announcement was expected from the Minister of Supply, Mr. Aubrey Jones.

For the moment, the industry is working flat out on delivering present generation missiles and aircraft, and export figures continue to break all records. For the next generation, most firms are better equipped to turn the goods out than ever before. In the past five years, private and Government research facilities have been enormously expanded, and they are undoubtedly the most advanced in Europe. A great deal of experience has been obtained on building and marketing civil aircraft. The weapons system concept has also at long last been developed to a high stage of efficiency, outstanding examples of this being the English Electric P.1B and the Blackburn NA.39.

Meanwhile, the visitor to the 1958 SBAC show at Farnborough will find not only greater variety and the hitherto secret results of past basic research, but also a number of entirely new aerodynamic and powerplant concepts in the advanced project stage. These are waiting for the official starter's gun, which, at the moment, seems to have gone rusty!

The British Aircraft Industry in 1958...
From the Outside Looking In

By E. Baur

For months, if not years, dyed-in-the-wool pessimists have been forecasting an inevitable decline in world trade, a drop in raw material prices and resulting wide-spread unemployment. Admittedly there are recognizable signs of a certain degree of sales resistance, hesitancy in placing new orders and an increased emphasis on economy; yet it can also be said that—particularly in the case of Britain—the slackening of the boom has not reached the proportions of the recession which hit the United States last winter. At any rate, the British Government seems to be prepared to ease credit conditions for industrial investment, and Minister of Supply Aubrey Jones has promised that Government aid will still be forthcoming to finance aeronautical research and support the industry "in the interests of defence". There is just one proviso: that the industry should reorganize and rationalize in such a way that, when the time comes, it can itself carry the major part of the costs of civil research. The Government is fully aware, however, that financial assistance will be required to develop a new generation of military aircraft and missiles.

In his statement on a proposed reorganization of the British aircraft industry the Minister of Supply advocated a "strengthening of units", in other words the formation of groups with considerable financial, technical and production resources.[1] The first signs of a reorganization are already discernible, and an overall picture of the present situation was drawn in *Interavia* No. 5, 1958 under the title "British Aviation Prospects".

Consolidation and rationalization will inevitably be bound up with a noticeable reduction in payrolls. In January 1955 the British aircraft industry employed a total of 240,900 persons; by January 1956 this number had increased by 10,000, and the January 1957 figure of 266,000 was the highest since the end of the war. Today there has already been a slight fall in employment (January 1958: 256,400), but far more radical cuts are being demanded. The Government target is to reduce the payroll within the next five years to roughly 150,000 men, the pre-Korean figure.

Despite economy measures, rationalization and consolidation, the trend of business is scarcely as discouraging as many would have it believed. A glance at the export figures suffices to reveal that not everything is as black as it is painted. During the first five months of the year alone, exports of aeronautical equipment reached a total value of £64,508,197, while the total for 1957 was £116,471,110 and for 1956 the figure was £104,460,562. And the Society of British Aircraft Constructors has stated that exports since the end of World War II have brought in the handsome sum of £650,000,000, with £167,000,000 of this total being accounted for by engines.

[1] The Minister pointed out that there are today fourteen leading airframe manufacturers and five engine manufacturers, whereas in his view there is room for at most four airframe companies and two engine firms.

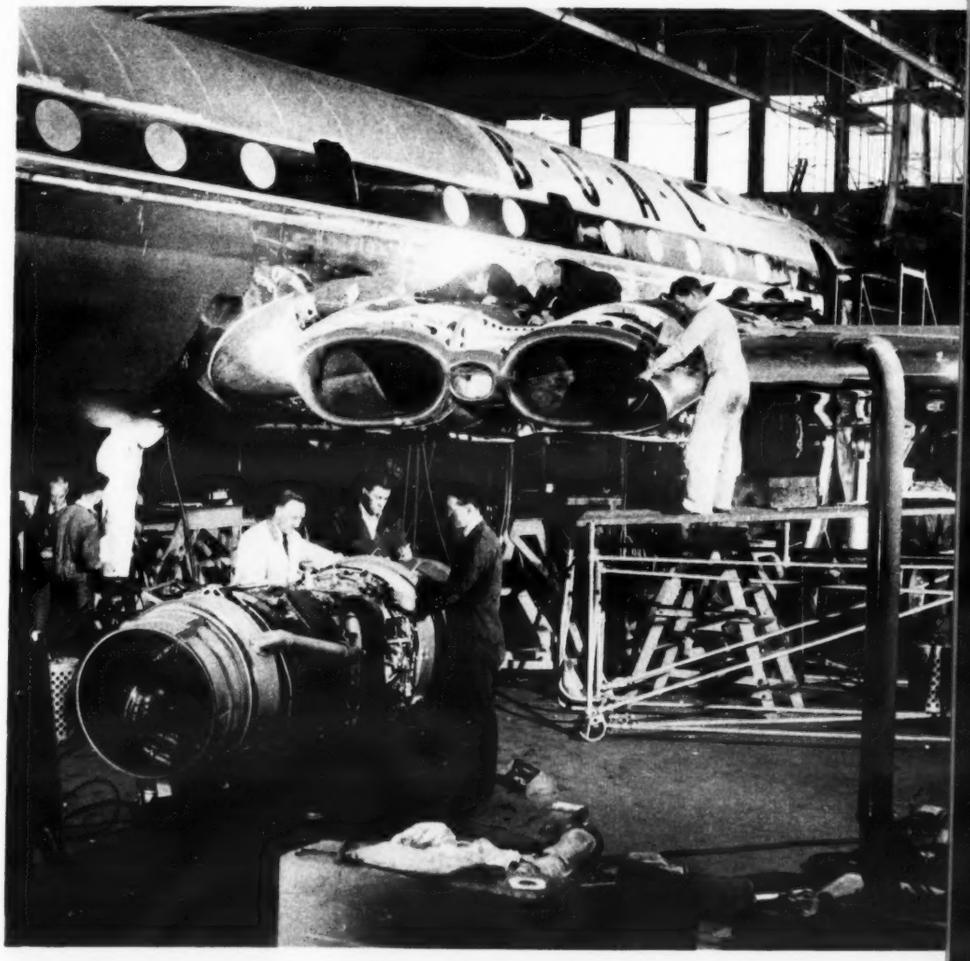
*

The civil market and growing international competition

Although it is indisputable that a good portion of the industry is working on a sounder basis than at any time since the war, the cuts in military orders have nevertheless made themselves felt. Moreover, growing international competition, particularly on the civil market, demands the greatest efforts from the British industry if the sales of British aircraft are to be expanded and the development of future civil equipment is not to suffer. This will require financial resources such as no single company, or even group of companies, can muster without assistance. Nothing less than substantial military contracts, i. e., Government money, can balance the expenditure on the civil sector. Whereas, for example, the order backlog of three of the leading U.S. manufacturers is made up of roughly 70 percent military contracts and 30 percent civil orders, the ratio is the exact reverse for many of the British firms.

Vickers-Armstrongs (Aircraft) Ltd. is today living mainly on civil business *(Viscount, Vanguard* and, later VC.10), since production of the *Scimitar* for the Royal Navy takes up relatively moderate space. Yet Vickers is planning to extend the market for the *Viscount* series through the introduction of the V.790 version for local services.

De Havilland is at present concentrating its main efforts on production and sale of the *Comet 4* and *Comet 4B* jet airliners. BOAC is to place the first *Comet 4* in service on its Atlantic routes at the end of 1958, and BEA expects to receive its first *Comet 4Bs* at the end of next year. Picture shows *Comet 4* production at Hatfield; in the foreground, a Rolls-Royce *Avon RA.29* engine, such as is mounted in the *Comet 4* and *Comet 4B*. The RA.29 has been certificated by the Air Registration Board for an operating life of 1,000 hours between overhauls.



The Bristol 192 turbine-powered helicopter (two Napier *Gazelles*) is in production for the RAF; a civil version, designated 192C, is also available.

Meanwhile the *Vanguard* will be ready for flight testing this autumn, and new versions of this civil transport with Rolls-Royce *Tyne* engines have been announced. These are the *Vanguard Mark II* with payload increased to 29,000 lb., and the *Vanguard Freighter* with a payload of roughly 40,000 lb.

In this connection the company's annual report for 1957 put forward an interesting line of reasoning. Many airlines, the report argued, have so exhausted their financial resources in procuring long-range jets that they will have little or no money for the purchase of short and medium-range equipment for at least a year. Thus the *Vanguard* and local service *Viscount* should be coming on to the market at a very favourable moment.

Another firm in much the same position as Vickers is the *de Havilland Aircraft Company Ltd.* Though this company has very active missile and engine departments, it is today concentrating its main efforts on production and sale of the three versions of the *Comet* jet. A new market is shortly expected to open up for this aircraft in Canada. De Havilland points out that BOAC will be flying the first *Comet 4s* across the Atlantic by the end of the year. On the production side, the aim is to increase monthly *Comet* output to four aircraft. Production of this type is expected to continue until about 1963/64, counting the orders still likely to be received. By this time the three-jet D.H.121 ordered by BEA will be going into production alongside the remainder of the *Comet 4s*. De Havilland considers that prospects for the sale of a high-speed aircraft for relatively short stage lengths are definitely good. This view is supported by American figures showing that roughly 30 percent of the U.S. domestic traffic volume is carried over stage distances of between 50 and 250 miles, while another 15 percent is booked on block distances of between 500 and 750 miles; only a bare 20 percent falls into the 1,000 miles-plus bracket.

Meanwhile de Havilland can boast that its civil and military jet transports have attained an impressive number of flying hours, as the various versions of the *Comet* have so far more than 52,000 flying hours to their credit. De Havilland's Aircraft Servicing School has also developed a systems trainer for BOAC with which normal and exceptional flying conditions can be simulated and on which BOAC air and ground crews are already training. Similar courses are planned for the crews of other *Comet* purchasers (BEA and Aerolineas Argentinas).

The third large organization engaged to a substantial extent on the production of civil equipment is the *Bristol Aeroplane Co. Ltd.*, whose aircraft subsidiary (Bristol Aircraft Ltd.) is responsible for production of the turboprop *Britannia*. This aircraft needs no further introduction, since it has been in service on BOAC's routes since February 1957. Two relatively small airlines, El Al Israel Airlines and Aeronaves de Mexico, are also operating the *Britannia*, and other companies (Canadian Pacific, Cubana de Aviación, Hunting Clan) are about to take it into service. Operating hours have risen rapidly, and BOAC is now employing its *Britannias* at the rate of 3,000 hours a year.

Meanwhile a new version of the long-range *Britannia* has been announced. This is the 320 series, with Bristol *Proteus 765* turboprops of 4,445 e. h. p. each. The 320's performance will be markedly superior to that of the earlier 310 model.

Though Bristol foresees an excellent future for large long-range turboprop transports, the management is also of the opinion that there are good sales prospects for a smaller jet airliner. This is

Farnborough 1958

Peter G. Masefield, Managing Director of Bristol Aircraft Ltd., on . . .

Turbo-Prop Prospects

At a time when economic performance is one of the most desirable requirements in air transport operations, the future of the turbo-prop in commercial aviation *ought* to be assured. In many thousands of hours of airline service turbo-prop transport aircraft—represented by the Vickers *Viscount* and the Bristol *Britannia*, soon to be joined by the Lockheed *Electra* and the Vickers *Vanguard*—have shown that they have five fundamental qualities. They are: economic in operation, attractive to passengers, reliable in service, undemanding on runways—in length or strength, quiet.

One could add also, that the turbo-props have shown themselves to be usefully faster than contemporary piston-engined aircraft—the *Britannia*, for example, holds the commercial "Blue Riband" of the Atlantic in both directions, with substantially shorter crossings than by any previous commercial aeroplane.

Doubts which exist, however, about the future of the turbo-prop stem from the shadows of the big jets casting themselves across the future prospects. Anyone who doubts that the jet aeroplane has a great place in the future of world aviation is being unrealistic. But will the jet oust the turbo-prop?

My belief is "No". Not, at least for very many years. Size for size the jet is, inevitably, going to cost more to operate than the turbo-prop. It is going to need longer—and stronger—runways. It is bringing with it noise problems which cannot be laughed off. And—in the present state of the art—the big jet when carrying an economic payload, may well prove to have less adequate range for non-stop Atlantic services than contemporary types of long-range turbo-prop and piston-engined aircraft.

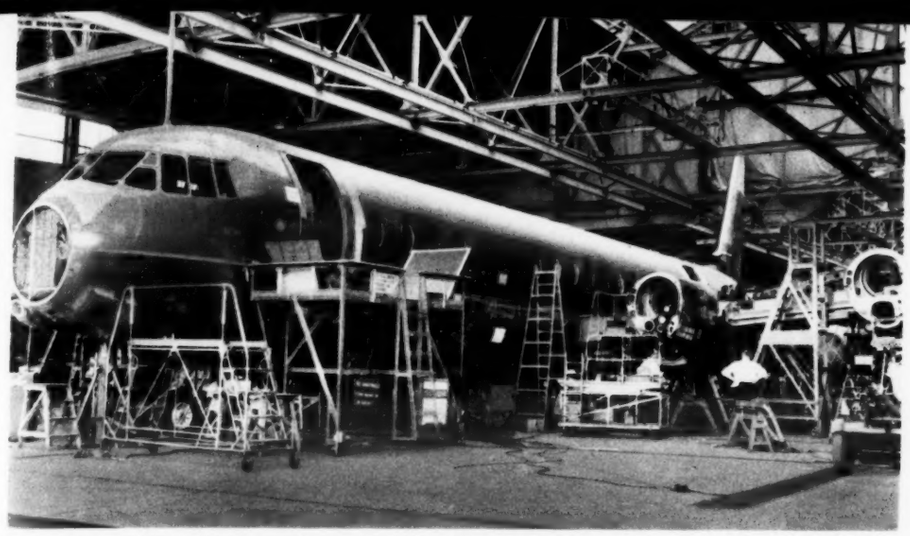
Against this background the turbo-prop offers a powerful and continuing challenge to the jet in the battle for a share of the world's air traffic.

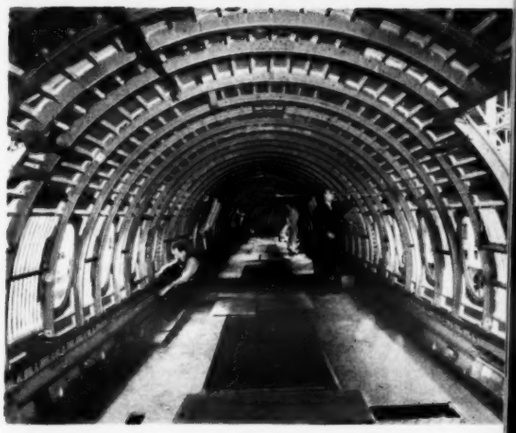
In the future development of world air transport, my belief is that, in due course, we shall see a differential fare structure applied between the faster jet and the other forms of aircraft—thus following through in the air what has already been standard on the sea throughout generations of travel.

In the longer-term future there seems little doubt that the public interest can best be served by a two-tier fare structure, in which higher fares for higher speeds and higher costs will be a logical pattern. In such a climate the future of the turbo-prop will be assured—providing a public service at the lowest possible cost.

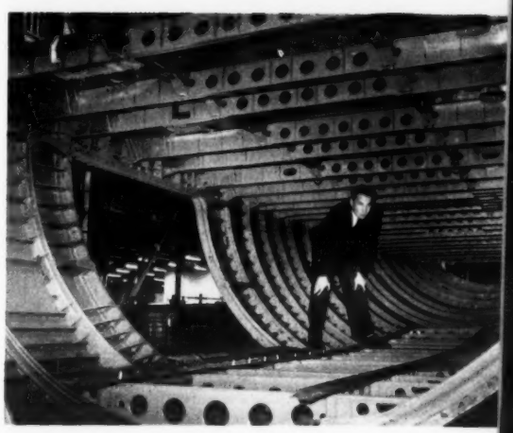
Some vested interests will struggle against it. But the laws of economics when allied to the public interest have a habit of working through—even in aviation.

Vickers VC.10 medium-to-long-range commercial transport, powered by four Rolls-Royce *Conways*. BOAC has placed an order for 35 of these aircraft and taken an option on another 20. The first VC.10 is scheduled to fly in 1961, and deliveries to BOAC are due to begin in 1963.





Vanguard production at Vickers Armstrongs' Weybridge plant. The first *Vanguard* is due to begin flight testing this autumn. Orders have so far been received from BEA (20 plus an option on a further 10) and TCA (20 plus an option on 4).



one of the reasons why the project for the Bristol 200 short-to-medium-stage transport for around 100 passengers has been shelved, at any rate for the time being. In its place Bristol now plans to devote its attention to a project for a short-range multi-jet aircraft for only about 70 passengers.

It should not be forgotten that production of the *Britannia* for military applications is continuing according to schedule, that the basic design of this aircraft has given rise to a number of new models (Canadair CL-28 and CL-44, also Short/Bristol *Britannic*), and that the potential market for the many variants has not yet reached saturation point in either the civil or the military sector.

Aircraft for feeder routes and special tasks

Some half dozen other companies are engaged on projects or construction of aircraft for feeder services or special applications, such as car ferries, etc. Behind many of these projects lies the almost legendary urge to produce a DC-3 replacement.

Opinions on what should be the configuration and size of this DC-3 successor are divided, though the general trend is towards a VTOL or STOL design. *A. V. Roe*, for example, has for some time been working on a short-take-off turboprop model to replace the DC-3. *Fairey's Rotodyne*[2] VTOL aircraft has aroused interest far beyond the frontiers of Britain, not only because it is a masterpiece of engineering but also because of economic considerations; the *Rotodyne* is generally described as ideal for inter-city service. *De Havilland* has designs for a twin-jet (Bristol *Orpheus*) feeder airliner, and as long as twelve months ago *English Electric*, whose main activities traditionally lie in the field of military aircraft and guided weapons, joined the ranks of the companies who—despite promising military sales—are also investigating the civil field. *Handley Page* is offering its 36/47-seat *Dart Herald* (two Rolls-Royce *Dart RDa.7/2s* of 2,105 s. h. p. each) for feeder operations, and *Scottish Aviation* is quietly going ahead with production of its 16-passenger *Twin Pioneer*, which is already in service with a number of smaller companies (de Kroonduif, New Guinea; Borneo Airways, Philippine Air Lines, Fison Airwork and Scottish Airlines) and with the RAF. *Hunting Aircraft* is engaged on a twin-jet short-stage transport for a maximum of 48 passengers, known as the H.107. A mockup of this aircraft (two Bristol *Orpheus* jets at the rear, *Caravelle* fashion) has been built, and wind tunnel measurements have also been completed.

Also of interest to the civil market are three helicopters: the Bristol 192C (two Napier *Gazelles*), the military version of which, the Type 192, is now in production; and the civil versions of the Westland *Wessex* and *Westminster* turbine-powered helicopters, the former for up to twelve and the latter for up to 45 passengers.

Finally, in a class by itself are the *Armstrong Whitworth AW.650* and the same company's projected *Airbus*, as well as the planned civil version of the B.107A military transport from the stable of Blackburn & General Aircraft.

Military equipment problems[3]

Since the 1958 White Paper on Defence has given evidence of a radical change in procurement

[2] Cf. *Interavia* No. 6, 1958.

[3] Cf. table of British military aircraft and missiles.

BEA has ordered 24 of these de Havilland D.H.121 short-to-medium-range transports, with an option on another 12. Powerplant: three Rolls-Royce RB.141s.

The Bristol 200 is another project worked out to meet the requirement for a short-stage jetliner. However, Bristol has shelved this project, at any rate for the time being, in favour of a smaller multi-jet design for some 70 passengers.

British Services First-Line Operational Aircraft (in service or on order)

Manufacturer	Aircraft	Powerplant	Thrust (lb.)	Type	Remarks
RAF				**FIGHTERS, BOMBERS**	
Avro	Vulcan B.1	4 × Olympus	4 × 12,000	Medium bomber	In service; production nearly complete.
Avro	Vulcan B.2	4 × Olympus BOl.7	4 × 17,000	Long-range medium bomber	In production. Shortly in squadron service. Carries Avro stand-off bomb. Improved performance over B.1.
Avro	Shackleton MR.3	4 × Griffon	4 × 2,450 h. p.	Long-range maritime reconaissance	Standard Coastal Command equipment.
De Havilland	Venom FB.1	1 × Ghost	1 × 5,000	Single-seat attack	Phasing out of service.
English Electric	P.1B	2 × Avon RA.24	2 × 11,000* + reheat	Single-seat all-weather fighter	Capable M = 2. Armament guided weapon, rocket battery and 30-mm cannon, "Airpass" fire control. In service early 1959. Later versions with *Double Scorpion* rocket. Two-seat trainer version and possible development in strike role.
English Electric	Canberra	2 × Avon	2 × 7,000 to 10,000	Light bomber; attack and P. R.	In large-scale service, B.6, T.7, B(I)8. High-altitude PR.Mk.9 now being delivered.
Gloster	Javelin	2 × Sapphire	2 × 9,000* + reheat	Two-seat all-weather fighter	Large-scale service Mks.1, 2, 4, 5, 6, 7 and Mk.8 with afterburners. Armament 4 × *Firestreak;* rocket battery, 4 × 30-mm cannon. Also T.3 trainer.
Handley Page	Victor B.1	4 × Sapphire	4 × 9,000*	Long-range medium bomber	In service; production nearly complete.
Handley Page	Victor B.2	4 × Conway	4 × 16,500*	Long-range medium bomber	Improved performance. Carries Avro stand-off bomb.
Hawker	Hunter	1 × Avon	1 × 10,000	Day fighter and attack	In large-scale service; F.6 and T.7. Fighter reconnaissance version expected. Production continues.
Vickers	Valiant B(K)1	4 × Avon	4 × 9,000*	Medium bomber	Nine squadrons equipped. Standard Bomber Command equipment.
				TRANSPORTS	
Blackburn	Beverley	4 × Centaurus	4 × 2,850 h. p.	Transport and freighter	47 built for Transport Command.
Bristol	Type 192	2 × Gazelle	2 × 1,650 s. h. p.	Transport helicopter	First aircraft flew in July 1958. In full production.
Bristol	Britannia 253	4 × Proteus	4 × 4,120 e. s. h. p.	Heavy long-range transport	Coming into service end 1958.
De Havilland	Comet 2	4 × Avon	4 × 7,300	Transport	Ten in service with Transport Command.
				TRAINERS	
Hawker	Hunter T.7	1 × Avon	1 × 10,000*	Advanced two-seat trainer	In standard RAF service. For export; can double as operational type.
Hunting Aircraft	Jet Provost T.3	1 × Viper ASV.8	1 × 1,750	Primary and basic trainer	Mks.1 and 2 in service. Mk.3 now being delivered, will replace Provost in Flying Training Command.
Folland	Gnat Trainer	1 × Orpheus BOr.4	1 × 4,230	Transonic trainer	14 ordered as development batch. Production to follow. In service 1959-60. Single-seat Gnat 1 may be used for close support.
De Havilland	Vampire Trainer	1 × Goblin	1 × 3,500	Advanced trainer	In standard service.
ROYAL NAVY					
Blackburn	NA.39	2 × Gyron Junior	2 × 7,000*	Strike	Transonic strike. Special navigation and weapon delivery systems (atomic). Pre-production batch being built. Production to follow. Backed by $13 million U. S. aid.
De Havilland	Sea Venom 22	1 × Ghost	1 × 5,000	Night fighter	Standard night fighter.
De Havilland	Sea Vixen	2 × Avon	2 × 10,000*	All-weather fighter	Now being delivered. In service 1958. 4 × *Firestreak*, r. p. battery and 4 × 30-mm cannon.
Fairey	Gannet AS.4	1 × Double Mamba	1 × 3,190 e. s. h. p.	Submarine search and strike	In full-scale service. Production complete.
Fairey	Gannet AEW.3	1 × Double Mamba	1 × 3,190 e. s. h. p.	Long-range radar warning	Prototype built. Production order in hand.
Hawker	Seahawk F.(G.A.) Mk.6	1 × Nene 103	1 × 5,400	Carrier-borne fighter	Armstrong-Whitworth responsible for production since mid-1953. Standard Navy aircraft.
Hawker	Hunter T.8	1 × Avon	1 × 10,000*	Advanced Navy trainer	Now going into service.
Vickers	Scimitar	2 × Avon	2 × 10,000*	Strike and day fighter	Now in service. Production continuing. Can carry Tac-A bomb; 4 × 30-mm cannon + bombs and external r. p.
Westland	Whirlwind	1 × Leonides Major	1 × 750 h. p.	Anti-submarine helicopter	In service.
Westland	Wessex	1 × Gazelle	1 × 1,650 s. h. p.	Anti-submarine helicopter	In production. First production machine flown June 1958. To be standard Navy anti-submarine type.

* Approximately

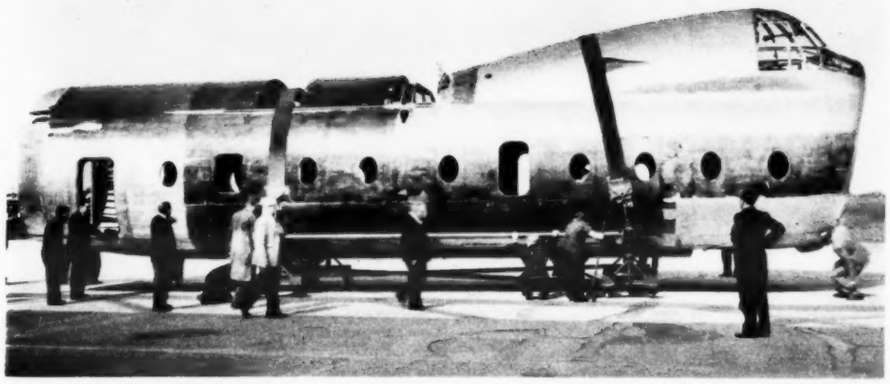
Britannia assembly at Bristol's Filton plant. Picture shows fuselage components for some of the 18 *Britannia 312s* to be delivered to BOAC.

plans for military equipment, and the idea of replacing manned aircraft almost entirely by missiles, as envisaged in the 1957 White Paper, has been abandoned, the RAF and the Royal Navy appear in general to have tailored their procurement programmes to the needs of the immediate future. This does not mean, however, that they are not continuing to attach capital importance to the development of guided weapons.

Thus the RAF stressed only recently how essential it considers the stepped-up procurement of manned aircraft to be. At the same time, however, it made it quite clear that new funds should be granted urgently for research and development purposes, if it is not to fall behind in space research.

Despite all the discussion and the doubts expressed on the air forces' present equipment and striking power, the neutral observer comes away with the impression that the RAF and the Fleet Air Arm are equipped with respectable quantities of first-class aircraft. Take for example the V-bomber fleet, whose combat value (with A-weapons, stand-off bombs, etc.) can be only approximately estimated. Incidentally, recently announced production figures reveal that of the 260 V-bombers ordered roughly 160 have already been completed. Total orders covered 108 Vickers *Valiants* (deliveries completed), 77 Handley Page *Victors* and 75 Avro *Vulcans*.

For its part *English Electric* is producing the P.1 supersonic fighter weapons system in large numbers, and the P.1B version with Ferranti *Airpass* radar fire control system will be going into squadron service in 1959. In the P.1B the RAF will have one of the most efficient fighters ever built and taken into service in Europe. An important factor is that the P.1 has two engines, which means that it remains combatworthy even if one engine fails and thus has the safety factor lacking in other, single-engine, high-speed fighters. At



Fuselage component for the first prototype of Armstrong Whitworth's AW.650, which is to begin flight testing before the end of the year. Ten aircraft of this type are in production as a private venture. Powerplant: four Rolls-Royce *Dart RDa.7/2s* of 2,105 s. h. p. each.

English Electric, too, production of the twin-jet *Canberra* in several versions is continuing. This aircraft, which is in service with the RAF as light bomber, reconnaissance aircraft and trainer, is also exported in substantial numbers, and there is talk of still newer versions to come.

Large-scale production of the *Hunter* fighter and strike aircraft, and of a two-seat trainer version is in full swing at *Hawker*, who has scored export successes with this aircraft such as have previously been equalled only by the Havilland's *Vampire* and *Venom*. Moreover, the *Hunter's* development potential by no means appears to have been exhausted. For example, an all-weather version with airborne radar, and a reconnaissance model of the *Hunter 6* for the RAF are in preparation. Hawker has even gone further and projected a six-seat executive aircraft, with two *Orpheus* jets at the rear and using the basic *Hunter* design.

Some time ago Hawker also began work on the project for a new-generation combat aircraft, in the shape of the P.1121. This aircraft could be employed not only as a Mach 2+ interceptor, but also with equal efficiency for low-level strike operations. Finally, Hawker is also involved in the development programme for a lightweight VTOL combat aircraft, to meet future RAF requirements for a short-range light strike fighter, such as also figures in the NATO procurement programme.

Short Brothers & Harland is continuing its test programme with the SC.1 VTOL research aircraft, and *Saunders-Roe* is actively pursuing trials with the high-speed SR.53.

Political tension in the Middle East has once again brought the question of a strike fighter for the RAF into the foreground. The *Hunter's* qualities as a ground attack aircraft have already been mentioned. A second design which seems to meet the RAF's basic requirements is the jet-powered *Folland Gnat*.

Obviously, the RAF's arsenal includes a whole range of other aircraft types. One of these is the *Gloster Javelin* all-weather fighter, the latest ver-

Basic Data on British Guided Weapons

Manufacturer	Weapon	Code name	Role	Guidance	Remarks
Armstrong Whitworth	Seaslug	–	Ship–air	Semi-active	Undergoing sea tests. To be standard fleet A. A. weapon. Associated companies: GEC, Sperry, EMI, etc.
Avro	Stand-off bomb	–	Air–surface	–	Winged, rocket-propelled bomb, now on test in U. K. and Woomera. Stage 2 under development: probably longer range. Carried on *Vulcan B.2* and *Victor B.2*.
Bristol/Ferranti	Bloodhound	Red Duster	Surface–air	Semi-active	In service. First RAF operational weapon. Stage 2 development being considered.
De Havilland Propellers	LRBM	Blue Streak	Ground–ground	–	Flow tests etc. now at Hatfield. Firing tests at Woomera. Fired from underground pits. Speed 10,000 mph. Length approx. 70 ft. Probably liquid plus solid motors. Nose cone test vehicle believed *Black Knight* now under test at Woomera. Associates: Sperry (guidance); Rolls-Royce (motors).
De Havilland Propellers	Firestreak	Blue Jay	Air–air	Infra-red	In production. Standard RAF/RN weapon. Acceptance tests satisfactorily completed. For use on P.1B, *Sea Vixen, Javelin*. Stage 2 under development.
English Electric	Thunderbird	Red Shoes	Surface–air	Semi-active	In production. Mobile or fixed base. Associates: Marconi and Napier. Solid-fuel or liquid motors. Standard Army weapon. Batch of Stage 1 weapons for RAF. Stage 2 under development for RAF and Army.
Fairey Aviation	Fireflash	Blue Sky	Air–air	Beam rider	In production. Standard RAF training weapon, but fully operational. Associates: Plessey and E. K. Cole.
Fairey	–	–	Ground–ground	–	New type anti-tank weapon. No details available.
Short	–	–	Ship–air	–	Under development for Royal Navy. Developed from SXA.5 test vehicle. Believed short-range weapon for low-altitude work.
Vickers	Type 891	–	Anti-tank	Wire	Private venture infantry weapon. Under active development.

The de Havilland *Sea Vixen FAW.1* two-seat all-weather carrier-borne fighter with *Firestreak* missiles.

sion of which (FAW.8) recently began flight testing and has now gone into production. *Hunting Aircraft* is also building the *Jet Provost T.3* light trainer in large numbers. This aircraft has given renewed proof of its qualities in the recent operational trials by the Peruvian Air Force.

Turning to the naval side of the picture, we find the Fleet Air Arm facing considerable difficulties over the procurement of future aircraft, particularly since production of the Saunders-Roe P.177 supersonic carrier-borne fighter has been cancelled. At present the *de Havilland Sea Vixen FAW.1* two-seat all-weather carrier-borne fighter is going into service at an accelerated pace to replace the *Sea Venom,* and the *Vickers-Supermarine Scimitar F.1* carrier-borne low-level strike aircraft to replace the *Sea Hawk*. A pre-production batch of twenty *Blackburn & General Aircraft* NA.39 all-weather strike aircraft, with two de Havilland *Gyron Juniors,* is under construction.

Yet the Navy does not believe that these three modern aircraft will be adequate for defence against high-flying long-range bombers, particularly as none of them are capable of supersonic speeds in level flight, much less in climb.

The question of what aircraft the Navy will finally get as an efficient supersonic interceptor

Transport Projects

In recent weeks the RAF has repeatedly and unmistakably expressed the view that the procurement of a substantial number of modern long-range transport aircraft to meet Transport Command needs has reached a high degree of urgency. A number of British manufacturers have already submitted projects for efficient troop and cargo transports to the Air Ministry or the Ministry of Defence. These include the Armstrong Whitworth AW.660, Short/Bristol *Britannic* in four different versions, Blackburn B.107A, Handley Page HP.111, a development of the Vickers *Vanguard* with rear loading doors. In addition there is a de Havilland project for a pure freight version of the *Comet 4* with new fuselage and provision for freight loading via a rear door.

At the time of going to press, however, no decision had been made as to the award of a development or production contract.

The following technical details have been revealed for the above-mentioned projects:

● **Armstrong Whitworth AW.660** — originally designed for four Rolls-Royce Dart RDa.7/2 turboprops of 2,105 eshp each, the AW.660 would have a max. gross weight of 82,000 lb.; max. payload 27,000 lb.; range with max. payload 650 nautical miles at 260 knots; max. range with 11,000 lb. payload 2,700 nautical miles. Over shorter distances up to 75 fully equipped troops could be carried. Take-off distance to clear a 50-ft. obstruction is given as roughly 1,060 yards.

● **Short/Bristol PD.18 Britannic** — Large transport combining the *Britannia* wing with a fuselage to be developed by Short. In this project Short is offering an aircraft which could be developed step by step for increasingly high capacity. Four development stages are envisaged, the second of which (*Britannic 2*) would particularly meet Transport Command's immediate requirements:

PD.18/4 Britannic 1 for service by 1961; payload around 60,000 lb.; gross weight 180,000 lb.; Bristol *Proteus 766* turboprops.

PD.18/5 Britannic 2 for military and civil applications, with more powerful *Proteus 4* engines, improved (high activity) propellers and new wing fillets to raise critical Mach number. Gross weight 183,500 lb.; cruising speed 310 to 330 knots (at 20,000 ft.); block distance up to 4,400 nautical miles; max. payload approx. 60,000 lb. or 197 passengers; span 142 ft. 3.5 in.; length 134 ft.

PD.18/6 Britannic 3 with Rolls-Royce *Tyne 2* turboprops and structurally reinforced fuselage for a payload of 75,000 lb.; gross weight 195,000 lb.

PD.18/7 Britannic 4 with fully-developed *Tyne* (or Bristol *Orion*, if development is resumed) and a gross weight of 220,000 lb.

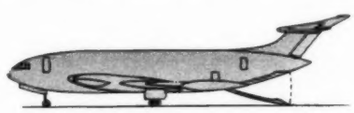
● **Handley Page HP.111** — Derived from the Victor (B 2?) four Rolls-Royce *Conway* jet engines (probably RCo.11s). Gross weight 225,000 lb.; cruising speed 470—500 knots, or 300—400 knots, depending on mission. Cruising altitude approx. 40,000 ft. for long ranges; max. still air range 5,000 nautical miles. Take-off distance to clear 50-ft. obstruction 2,000 yards, or 1,200 yards with loads for 2,000 nautical mile range.

● **Blackburn B.107A** — Would use major components from the *Beverley* and could also be used as a civil freighter. With four Rolls-Royce *Tyne R.Ty.11* engines, the B.107A would have a design gross weight of 175,000 lb. and a design landing weight of 155,000 lb.; max. payload would be 58,000 lb. Maximum cruising speed at 150,000 lb. mean weight would be 306 knots at 25,000 ft.; ceiling 33,000 ft. Range with max. payload 1,300 nautical miles, with full fuel 4,400 n.m. Normal take-off to 50 ft. (at max. gross weight) 1,210 yards; with 150,000 gross weight 920 yards.

Armstrong Whitworth AW.660 for a maximum of 75 troops. Span 115 ft.; length 87 ft. If the latest *Dart RDa.10/2s* of 3,200 e. s. h. p. each are used, gross weight could be raised to roughly 82,000 lb. and maximum payload to roughly 27,000 lb.

Blackburn B.107A with four Rolls-Royce *Tyne* turboprops of approx. 5,300 e. s. h. p. each. Wing and tail units taken over unchanged from the *Beverley;* fuselage completely redesigned; main undercarriage to be retracted into streamlined bays on the fuselage sides.

Short/Bristol PD.18 Britannic: The drawing above shows the PD.18/5 *Britannic 2* version—four Bristol *Proteus 4* propeller turbines. Rear loading door and access to cargo hold in the fuselage sides are envisaged. Manufacturing costs (without passenger equipment) will probably amount to £1,000,000.



Handley Page HP.111, derived from the *Victor* V-bomber (identical wing and tail units; newly designed fuselage with circular section). Projected powerplant four Rolls-Royce *Conway* by-pass engines.

An artist's impression of the private venture Hawker P.1121 air superiority fighter/attack aircraft, which is 90% complete at Hawker's, though so far no RAF orders have been received. The 1121 (length about 60 ft.) is powered by a de Havilland *Gyron* with reheat and has been designed as either a single or a two-seater. Provision has also been made for alternative engine installations, such as Bristol *Olympus*, Rolls-Royce *Conway* or Orenda *Iroquois*. Very heavy external loads, including atomic weapons, can be carried.

Blackburn NA.39 naval low-level strike aircraft, equipped with two de Havilland *Gyron Junior* jets. Substantial U. S. funds have been made available for the development and production of the NA.39.

Handley Page *Victor B.1* V-bomber, which is going into squadron service with RAF Bomber Command this year. Powerplant: four Armstrong Siddeley *Sapphires*.

therefore remains open. Some circles believe that the *Folland Gnat Mk.2* (reheat *Orpheus; Firestreak* armament; Mach 1.2 to 1.3) may well come closest to Navy requirements on this point.

A switch-over in procurement policy is also envisaged as regards anti-submarine aircraft. *Fairey*, for example, has completed production of the AS.4 model of the *Gannet* anti-submarine aircraft, and it seems certain that anti-submarine duties—at any rate in coastal areas—will in future be handed over to rotary-wing craft. Two *Westland* designs, the *Whirlwind HAS.7* and the *Wessex*, have therefore been developed primarily as anti-submarine helicopters. The *Whirlwind HAS.7* (Alvis *Leonides Major* piston engine) has been in service with the Fleet Air Arm since mid-1957, while the *Wessex*, with Napier *Gazelle* turbine, is to go into squadron service this year. Another new aircraft for the Navy is the AEW.3 radar early warning version of the Fairey *Gannet*, production of which is now under way.

Engines . . . a first-class export line

Minister of Supply Aubrey Jones' statement, referred to above, that in his view there was not room for more than two major engine manufacturers may today appear somewhat drastic. Yet the engine companies are already showing signs of coordinating their activities. One example is the creation of Bristol-Siddeley Engines Ltd. By amalgamating production resources, companies are aiming at putting themselves in a better position to meet future requirements and cover the whole field of engine production in the preparation of new projects.

At *Bristol Aero-Engines Ltd.* production and development of the *Proteus* turboprop are being energetically pursued; the *Proteus 3* version is in production, and a *Proteus 4* version is being developed for the 5,000 s. h. p. class. Recently Bristol also announced three new models of this engine, which differ from their predecessors in reduced fuel consumption and—in two cases—higher performance. These are the *Proteus 761* of 4,210 t. e. h. p., the *Proteus 762* of 4,350 t. e. h. p. and the *Proteus 765* of 4,445 t. e. h. p. (for the *Britannia 320*).

Overhaul life of the earlier *Proteus* version (Type 705) as fitted in BOAC's *Britannia 102* was extended to 1,300 hours in April this year (after thirteen months of operational service), and this figure has just risen to 1,600 hours.

In addition Bristol is producing the *Olympus* high-power jet engine, the BOl.7 version of which (17,000 lb. thrust) equips the Avro *Vulcan B.2* V-bomber. However, Bristol's best seller is undoubtedly the medium-power *Orpheus* jet,

Avro *Vulcan* and Vickers *Valiant* (rear) V-bombers.

T. Brooke Smith, Chief Test Pilot, Short Brothers and Harland, on . . .

The Short SC.1

The SC.1 is in every essential a research vehicle—indeed it is almost a flying laboratory. Its immediate uses are twofold: to sort out the many problems associated with vertical and translatory flight applicable to the "flat riser" and to provide the means for flight development of the necessary "hardware" to overcome these problems. Later on will see its use in the development of automatic control, thus to enable the whole process of translation and vertical landing to be made without the aid of the human hand at all.

The Aircraft

The SC.1 is a delta-wing aircraft. The delta plan was chosen since it lends itself to the experiment both geometrically and structurally. It is powered by five Rolls-Royce RB.108 gas turbines; four providing lift and the fifth propulsion. The lift engines can be tilted either side of the vertical to assist in accelerating or decelerating the aircraft during translatory flight.

Control is by means of conventional ailerons, elevators and rudder but in addition four jet nozzles or "puffers" are positioned at the nose, tail and under each wing tip to cater for the hovering and near hovering condition. These latter are supplied by air bled from the lift engine compressors.

A system of "full" and "semi" auto stabilization is incorporated so that either degree of stability can be applied to the aerodynamic surface or "puffers" separately or to any combination of both.

The main chassis has two positions—the legs moving in relation to the centre of gravity—*forward* for the conventional take-off and landing, and *aft* for VTOL. The former gives a ground attitude of about 7° and the latter a near horizontal "sit". In the aft position the main wheels become "free to castor", thus obviating the effects of side load and enabling the aircraft to move along the ground in any direction. Chassis position is hydraulically operated from a pilot-operated selector lever in the cockpit.

It is unfortunate that, due to its classification, little more can be told of its many interesting features.

Pilot's Approach

When my company became interested in the VTOL specification for which the SC.1 was submitted, I at once set myself to learn something about it—firstly through the medium of the helicopter, and later with the Rolls-Royce VTO rig or TMR—more affectionately known as the *Flying Bedstead*.

This experience has been of inestimable value to me and was put to very good purpose in the design basics of the SC.1 which was "flown" both as a conventional aeroplane and in hovering and vertical flight on an electronic simulator designed and built by the firm, long before many of its component bits and pieces had been manufactured.

Design derivatives brought up to date as a result of wind tunnel tests were set up on the simulator and their flyability assessed; adjustments then being made, as necessary, to achieve the handling characteristics desired. Auto stabilizer constants giving the required degree of stiffness and response were similarly selected. At the same time, as will be appreciated, I was able to come to grips in advance with the aeroplane in both conventional, hovering and vertical flight.

Later, when a dynamic simulator rig designed by the firm for the purpose of carrying out a lengthy programme of functional tests of the hydraulic auto stabilizer system became available, further handling and familiarization checks were made.

It is interesting to record that these tests confirmed the auto-stabilization characteristics selected during the earlier electronic simulator trials. The dynamic rig will also be used for special "emergency" tests, in one of which the result of a failure in one of the four lift engines will be simulated. This will be achieved by moving a mass on the simulator to give an out-of-balance moment equal to the displacement of the vertical jet thrust centre and at the same time shutting one of the ports in the air distributor head.

Flying Technique

Stability in vertical flight is non-existent. One is dealing with something that behaves much as a fish in the depths, except for the fact that buoyancy is controlled by high velocity air rather than by that stored in a bladder. However, since in all other respects the "platform" is stabilised, it will be appreciated that the "lift" or "vertical velocity" control is the master key to the pilot's handling problem.

Generally speaking, the flying technique for jet-borne vertical flight is something that is quite quickly and easily grasped. It is somewhat akin to learning to ride a bicycle. During the recent tethered trials with the SC.1 I was reported as having said that, were it not for the limit imposed by the restraining wires, I would have risen higher than I actually did with complete confidence. These were not empty words, for judging by the way things are shaping, this aircraft is going to prove no exception.

Sir Archibald Hope, Director, D. Napier & Son Ltd., on . . .

Converting Piston-Engine Transports

A major problem facing many airline presidents today is what to do with their present aircraft fleets when their new jets are delivered and in service. The days when big capital profits could be earned from the sale of redundant aircraft are gone, for few passengers will choose to travel at 250 m.p.h. block speed when for the same fare they can travel at 500 m.p.h. block speed. The older aircraft will be non-competitive, and their value much reduced. They must apparently either be down-graded to routes without jet competition or sold as scrap. The latter alternative would involve large capital losses at a time of expanding air traffic

A *Convair-Liner* equipped with Napier *Elands* for test and demonstration purposes.

and would be ridiculous. The former alternative will be impracticable because there will be few routes on which today's medium and long-range aircraft can be profitably employed without competition from turbo-props, even if there is no jet competition.

These are the hard facts of the present situation, and the outlook can only be improved by action on the part of the airlines themselves to make their present fleets competitive in the jet age. This they can do by modernising their aircraft—that is by replacing the present piston engines with turboprops for which in many cases the airframe was originally designed and stressed.

It is not possible to forecast when such modernization will happen. The economics of conversion are clearly affected by the written down and/or secondhand value of the aircraft to be converted. These values are themselves affected by the possibility of conversion. All that can be said with certainty is that ultimately the use to which any aircraft is put will be governed by the profits to be earned from such use directly or indirectly. If aircraft are converted rather than scrapped the final effect on the trading accounts of the airlines must be an improvement and therefore somewhere sometime at some price conversion will take place.

the various versions of which have so far flown in six different aircraft types and are already proposed as equipment for a round dozen aircraft models. The versions now in production are the *Orpheus BOr.2* (Type 701 of 4,520 lb. thrust, weight 790 lb.) and the *BOr.3* (Type 801 of 4,850 lb. thrust, weight 825 lb). Two further, more powerful models *(BOr.11* of 5,760 lb. thrust and *BOr.12* of 6,810 lb. thrust or 8,000 lb.-plus with reheat) are under development.

It is now some years since Bristol Aero-Engines' activities were extended to the field of ramjet engines. Today the *Thor* ramjet is in production for the Bristol-Ferranti *Bloodhound* surface-to-air missile. To facilitate development of this category of engine, Bristol has erected, as a private venture, a high-altitude test installation for simulated altitudes up to 100,000 ft. and speeds corresponding to Mach 3.5.

Armstrong Siddeley Motors Ltd., Bristol's partner in the new Bristol-Siddeley Engines, has designed two private-venture turbine engines, the P.181/P.182, and has thus joined the ranks of the companies working on a range of engines in the 1,000 h. p. class to power both fixed-wing and rotary-wing models. Armstrong Siddeley hoped to get the P.181 on to the test bed before the summer was out, and bench runs by the P.182 are scheduled for the coming autumn. In addition, production of the *Mamba* and *Double Mamba* turboprops and the *Viper* jet is continuing, and intensive research and development work is going forward on rocket engines. *Blackburn & General Aircraft*, who during the past four years has been producing a number of *Turboméca* small gas turbines under licence from the French designers, has now gone over to designing its own power units, making use of certain *Turboméca* design principles. Here the Blackburn A.129 turbine (850/950 h. p.), based on the *Artouste 600*, can be quoted as an example. The first engine of this new type will be ready for bench runs by October this year. A new-comer to the *de Havilland Engine Company's* production programme is the *Gnome* turbine, to be built under a licence agreement with General Electric, initially for helicopter propulsion, and later as a turboprop with a power of about 1,000 h. p. The first *Gnome* built in Britain is scheduled for testing in about March 1959, and official certification is expected in the autumn of next year.

Aubrey F. Burke, Deputy Chairman and Managing Director, The de Havilland Aircraft Co. Ltd., on . . .

The Scope for the Medium-Sized Jet and Differential Fares

On the heavily travelled routes such as those that cross the North Atlantic and those in USA the large jet is justified. However, on most of the other routes in the world, traffic offering to each airline will not support such large capacity vehicles. Here is the opportunity for the jet transport of moderate size.

Such an aircraft needs a range adequate to link the main centres of population and trade, must be able to use existing runways, and pay its way on moderate traffic. This category of jet involves a smaller economic risk, affords a first-class service, is highly flexible and can easily give higher frequencies as the traffic increases. Up to a limit, frequency itself always tends to generate fresh traffic, and on these less dense routes the limit is still some distance away. Therefore, the medium sized aircraft will be the right size for at least the next 8 to 10 years.

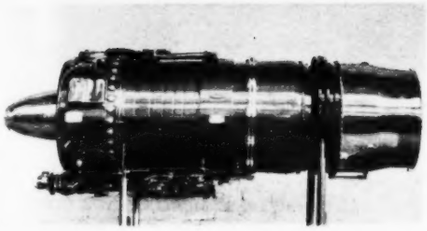
Differential fares between aircraft having different types of propulsion can only be justified economically if they are supported by a genuine difference in operating costs. At present such a fare structure would not be likely to achieve the result which is sought by its sponsors, for the difference, to be effective, would need to be substantial whereas operating costs are closely competitive. A small differential might react unfavourably to the slower aircraft, each aircraft type must find its place in the pattern by natural economic processes. There are certainly opportunities for both the jet and the propeller turbine.

De Havilland is also building substantial numbers of the *Gyron Junior* jet which is to power, for example, the Blackburn NA.39 naval strike aircraft, and development work on a version with reheat is in full swing. Work on the high-power *Gyron* jet is also being continued—at the firm's own expense—although no firm orders have yet been received. The latest version (with reheat) now has a thrust of 30,000 lb., and earlier American interest in this development (e. g., for the F-105) appears to have been revived of late. Finally, production of the *Spectre* rocket engine as a take-off aid is continuing at full pace; and the *Super Sprite* rocket engine is being used for similar purposes on the Vickers *Valiant* V-bomber.

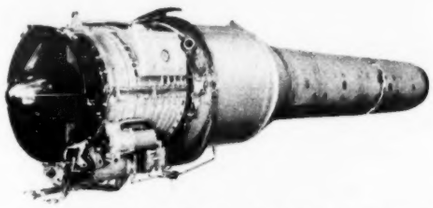
D. Napier & Son has expanded its programme during recent months by the addition of the *Gazelle Junior* (1,070 s. h. p.) which—like its pre-

Hunting Aircraft's *Jet Provost* trainer with Armstrong Siddeley *Viper ASV.8* jet of 1,750 lb. thrust. Side-by-side seats; equipment for day and night flying training.

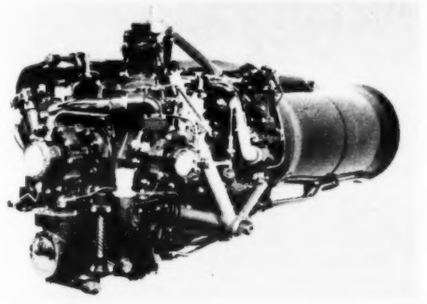
Flying testbed for the Bristol *Orpheus:* this F-86E *Sabre*, fitted with the *Orpheus 801* (BOr.3), began flight testing on July 3rd, 1958. The BOr.3 delivers a thrust of 4,850 lb. for an installed weight of 825 lb., while the F-86E's standard engine weighs 2,590 lb. and delivers a thrust of 5,200 lb.



De Havilland *Gyron Junior*. A reheat version is also under development.



Bristol *Orpheus 801* (BOr.3), as fitted for test purposes in the F-86E.



De Havilland *Spectre* rocket motor of approx. 8,000 lb. maximum thrust.

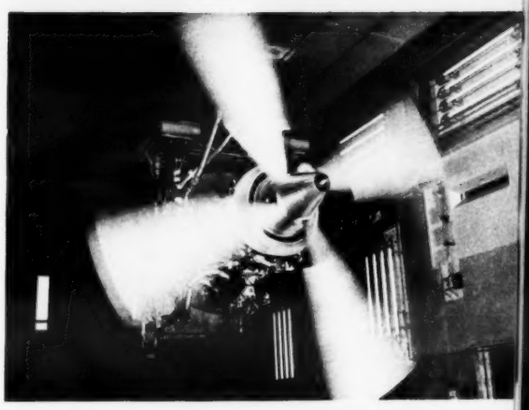
decessor, the *Gazelle*—is designed primarily for helicopter use. A dual version can be supplied if required. With the original *Gazelle*, which equips, for example, the Bristol 192/192C and the Westland *Wessex* helicopters, Napier has performed a feat of exceptionally rapid development; barely two years elapsed between acceptance of the first engine by the British Ministry of Supply and the award of a type certificate for 1,450 s. h. p. *(Gazelle NGa.13)* under combined U. K. and U. S. regulations. During development of this engine several versions of substantially higher power, such as the NGa.2 of 1,650 s. h. p., NGa.3 of 1,800 s. h. p., and NGa.4 of 2,000 s. h. p., were also built. The Napier *Eland* turboprop no longer needs special introduction, as it has been selected as standard equipment for the Canadair 540 transport ordered for the RCAF and is under consideration by several airlines desirous of re-equipping their piston-engine transports. An *Eland 229* variant of 2,800 s. h. p. is fitted in the Westland *Westminster* heavy helicopter, which has just begun flight testing, and *Eland* turbines have been chosen for the Fairey *Rotodyne*. Napier's production programme also includes the *Scorpion* and *Double Scorpion* auxiliary rocket engines. The last of these will form a power pack on an advanced model of the P.1B.

Meanwhile *Alvis Ltd.* is still going strong on production of the *Leonides* and *Leonides Major* piston engines, for both fixed-wing and rotary-wing aircraft. The company recently announced that a more powerful version of the *Leonides* is under development (625 h.p.).

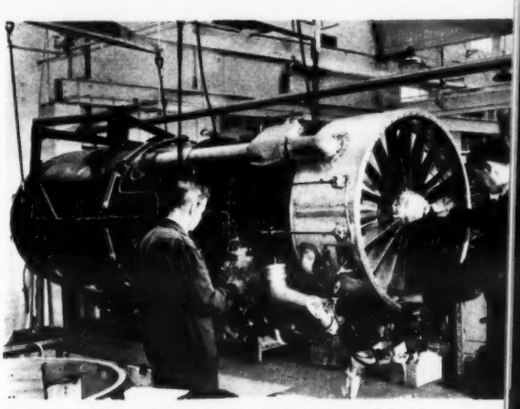
In passing it should be mentioned that several engine manufacturers stand a chance of a new market within the framework of the projects recently prepared for a naval reconnaissance and anti-submarine aircraft. Armstrong Siddeley *(Double Mamba)*, Napier *(Eland)* and Rolls-Royce *(Tyne)* appear to be on the short list.

Rolls-Royce, a company which for decades has personified private initiative and whose name has never been linked with any other undertaking (except where it has been a question of licence agreements), can look back on a good business year. By the end of the year the order backlog stood at roughly £112,000,000, compared with £90,000,000 the year before. Nevertheless, the Board is demanding increased efforts in the export field, as—despite national defence contracts—the company draws more than 50 percent of its business from the export market. In the military production domain, the *Avon* jet engine, in its many different versions, remains the most important product, though the *Avon RA.29* civil model *(Comet 4*, SE.210 *Caravelle)* also enjoys a growing reputation. This engine is certificated for a between-overhauls life of 1,000 hours, and two *RA.29 Mk.524* engines, as tested in the *Comet 2E*, have been run for 1,250 hours without showing appreciable signs of trouble in any of the components. In other words, a further increase in overhaul life can be expected in the near future for the civil version.

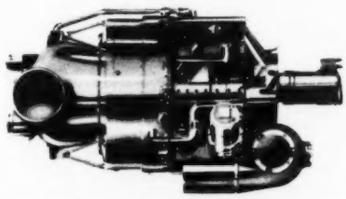
At the same time work on the *Conway* by-pass engine is continuing, on both the civil and the



Rolls-Royce *Tyne* propeller turbine on the test bench.

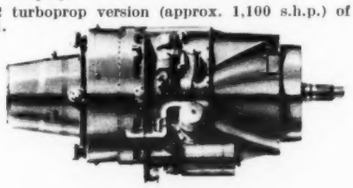


One of the first production Rolls-Royce *Conway RCo.11* engines. Thrust 17,250 lb.; fitted in the *Victor B.2*.

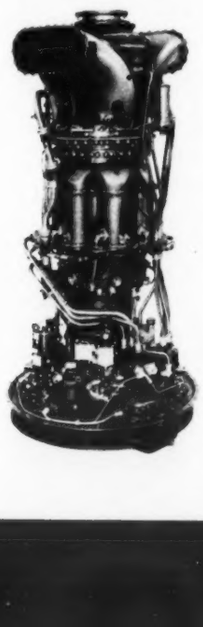


Armstrong Siddeley hopes to get the P.181 helicopter engine on to the test bench before the opening of the SBAC Display.

P.182 turboprop version (approx. 1,100 s.h.p.) of the P.181.



The Westland *Wessex* helicopter which is in production for the Royal Navy for anti-submarine duties. The *Wessex* is fitted with a Napier *Gazelle* gas turbine.



Bristol Aero-Engines took this high-altitude test installation, to be used primarily for development of ramjets (for missiles), into operation early last April. Altitudes up to 100,000 ft. and speeds equivalent to Mach 3.5 can be simulated.

military models. The first RCo.10s, with a guaranteed thrust of 16,500 lb. for civil use (in the Boeing 707-420 and the DC-8) should be ready for delivery by early September. The RCo.12 development of this engine, with 17,500 lb. thrust, is being offered to Boeing and Douglas for a somewhat later date. Neither the RCo.12 nor another projected civil *Conway* (RCo.15 of 18,500 lb. thrust) is yet in production. In the military sector the RCo.11 version (17,250 lb. thrust) is being produced in quantity for the Handley Page *Victor B.2* V-bomber.

However, the company's main activities in the civil field still lie in the production of the *Dart* turboprop. The some 700 to 800 *Darts* already in scheduled service have so far achieved the spectacular figure of roughly 5,000,000 operating hours. Average operating life between overhauls is today around 1,500 to 1,700 hours, though Trans Canada Airlines, for example, operates the *Dart 506s* in its *Viscounts* for 1,900 hours between overhauls, a figure which is shortly to be raised to 2,000 hours. Good progress is also being made in the development of the *Tyne* turboprop (e. g., for the Vickers *Vanguard*, the series of transports projected for the RAF and the Canadair CL-44). A total of 16 "development" engines has been built, and marked power increases for *Stage 1 Tynes* (to 4,500 s. h. p.) and *Stage 2 Tynes* (now 5,300 s.h.p.) have recently been announced.

Export efforts in the missile field

A year ago it was stated in these pages that one of the highlights of the last SBAC Display at Farnborough was the fact that British-designed guided missiles were on show in appreciable numbers for the first time. The same will doubtless apply to the 1958 Display, probably with increased accent. Here the reader is referred to the table showing details of the missiles now in production or under development. In practically all cases the hope has been expressed that export to other NATO countries will be approved. The most promising designs in this respect are the *Bristol Bloodhound* anti-aircraft missile, the *Fairey Fireflash* and *de Havilland Firestreak* air-to-air missiles, the *Armstrong Whitworth Seaslug* ship-to-air weapon and the *Thunderbird* anti-aircraft missile under development at *English Electric*. Some British missile manufacturers have gone even further and announced that they are willing not only to export finished missiles, but also to grant licences for production in other countries.

Though little new information is available on the above-mentioned "conventional" missiles (apart from the fact that, for example, an advanced model of the *Bloodhound* is in preparation, etc.), first concrete details of the British Long Range Ballistic Missile—also known under the code name *Blue Streak*—have now been released.

Prime contractors and coordinators for the development and construction of the *Blue Streak* are *de Havilland Propellers Ltd.* and *Rolls-Royce Ltd.*, with the *de Havilland Aircraft Co. Ltd.* acting as associate prime contractor. Tests on the *Blue Streak* have been in progress at Hatfield for some time, and first bench runs of the Rolls-Royce rocket engines for the missile have also begun. In the field of rocket engine development Rolls-Royce is working with North American Aviation.

Finally, reference must be made to a contract which the Ministry of Supply has recently awarded Short Brothers & Harland for a small ship-to-air missile, based on the Short SXA.5 experimental vehicle first mentioned last year.

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Obviously no general survey of the British aircraft and allied industries can go into full details in the space available. In particular, nothing has been said here of the electronics and accessories industries, whose new products are either discussed elsewhere in this issue under the heading "Telecommunications and Electronics" or will be dealt with in some detail after the SBAC Display.

To sum up, this year's show at Farnborough will include a number of new developments in both the civil and the military field. And what is by no means of least interest is that the separate exhibition of British missiles, first introduced last year, will be considerably expanded. Whereupon all that remains to say is . . . "see you at Farnborough".

Air Commodore F. R. Banks, Bristol Aircraft Ltd., on . . .

Quality

The British aviation engine will face its greatest test in the next decade, when it meets the full blast of heavily subsidized competition from America and, quite possibly, Russia.

While both America and Russia have enormously larger aircraft industries than our own, and are able to order engines in their thousands compared with our hundreds, they have no monopoly on quality. In fact, British engines have always stood well the comparison in respect of quality of manufacture and superiority of performance with any in the world; and, furthermore, this country probably has greater experience and background than any other in regard to the variety of forms which the propulsion gas turbine has taken for aviation, i.e. the turbojet, the propeller turbine, the by-pass, the gas generator with power turbine (for helicopters) and the small or moderate thrust, lightweight engine for vertical take-off.

Despite the weight of American competition, where one famous U.S. company has produced well in excess of ten thousand axial compressor engines for military use, and is already well-established in the large turbojet passenger aircraft now building and under test, British engines will also power the same machines.

There is an interesting possibility regarding these aircraft operating at or near the high subsonic limit, which is due to the fact that they are unlikely to be superseded except by the supersonic passenger machine; and that can hardly be expected on the airlines before, say 1970 or even later, so the obsolescence of the former may well run into fifteen years.

It may, therefore, be feasible to consider re-engining them in what would then be the second period of their operating life. Greater thrust would not give these large Mach limited turbojet machines increased speed, and could only be used for better take-off and climb; but an engine offering, say, 10 to 15 percent improvement in specific fuel consumption might well be attractive to the operator—if the fitting of new engines did not prove too costly.

This could then be a great challenge to the British engine industry, to develop engines of still better fuel economy.

Looking further ahead or, rather, anticipating the supersonic civil aircraft, special turbojets and ramjets are now under consideration for Mach 3 operation.

In regard to recent exhortations from the Government Departments concerned, to amalgamate, combine or consort: this will depend largely upon the scale of official support (orders) given and whether the firms concerned can offer complementary technical help and testing and manufacturing facilities, rather than mere duplication and "over-capitalization" in space and tools.

The writer has only given bare mention to Russia here, but it is almost certain that she will compete in the civil airline market before long. In fact, there are signs that she is already probing this field of activity; and no mistake should be made that her effort will prove other than formidable, since the USSR are in the position to undercut severely anything the Western Nations could offer. But it may be another few years before she has exactly the right type of aircraft, suited to the routes operated by the airlines of the Western world.

In the meantime, the British gas turbine engine in airline service shows steadily mounting operating hours between overhauls—with two thousand hours in sight.

The Farnborough Air Arsenal

Budget Restrictions and Great Power Commitments

By General Pierre M. Gallois, Paris

The last two White Papers on Defence have explained clearly and explicitly the basic essentials of the United Kingdom's new military policy. The general outline is simple, and the implications sufficiently obvious to have led to sharp public debate not only inside but also outside Britain.

The considerations behind the new policy, whose chief architects are said to have been members of Duncan Sandys' immediate *entourage*, were probably the following.

1. With the exception of Japan, Britain is probably the country most fully alive to the dangers of the thermonuclear age. The density of her population, the size of her cities, her proximity to the potential sources of attack and the vital role which the British Isles play as a forward bastion for the Western coalition—all these are good reasons why the British people should be particularly sensitive to the political and military significance of the existence of modern, highly destructive weapons.

2. Apart from Washington, London is the only Western capital which long ago grasped the implications of the new nuclear logic. Britain's island situation enables her military planners to pursue this logic to its natural conclusion.

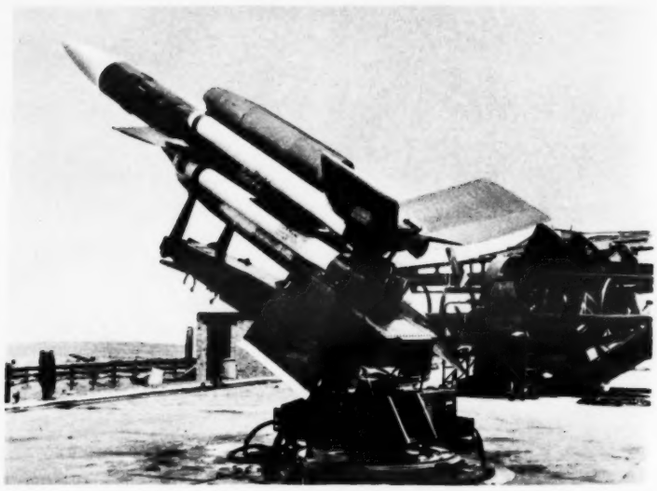
Those of us who participated in the preparation of the defence plan for Western Europe found in the first White Paper, three years later, the essentials of the new concept at which our working group had arrived in 1954. The build-up of aero-nuclear forces has introduced new factors, such as the weakness of active defence, the value of the deterrent and the threat of reprisals, and the supreme need to safeguard the reprisal force at all times from the effects of a surprise attack, to all of which the 1957 White Paper alludes more or less directly. Public opinion in Britain—as opposed to the military leaders—has obviously not understood the political and military implications of the nuclear age. Statements by Opposition leaders, the support given to a facile demagogic anti-atomic campaign and the attitude assumed by certain "intellectuals" reveal clearly that in Britain, as elsewhere, the general rule is to project the past into the present and to imagine that, but for the difference in destructive power, tomorrow's war will be the same as yesterday's. However, this attitude, which is found in the mass of the people in any country, is not shared by the responsible leaders.

3. The Suez affair showed how difficult it is for the democracies to conduct punitive expeditions of any larger scale in border-line conflicts. Both public opinion and Parliament experienced a marked feeling of uneasiness after Mr. Khrushchev's veiled nuclear ultimatum. France's experiences in Indo-China and Britain's in Malaya, to mention only these two examples, have illustrated the hazards of using force to maintain their positions in distant territories, in the face of the new nationalistic movements. Thus countries with limited resources naturally find it tempting to cut expenditures on the kind of forces required for operations of this nature. Yet British responsibilities outside Europe are too vast to make such economies feasible. On this point the 1957 White Paper said: "... Britain has undertaken in the Baghdad Pact to cooperate with the other signatory States for security and defence, and for the prevention of Communist encroachment and infiltration. In the event of emergency, British forces in the Middle East area would be made available to support the Alliance..."

4. Recent examples of police actions are the measures taken at Aden, Kuwait and elsewhere. In practice all that was required here was to deploy a few battalions in the Middle East and to keep them supplied from Britain or Kenya. No major difficulty was encountered, even though RAF Transport Command could call on only a few squadrons of aircraft with widely varying capacities. But things take on an entirely different hue when it comes to revolts by larger numbers of well-equipped rebels, and the reserves have been eaten away by economy cuts.

5. British public opinion is often more vividly aware of the drawbacks inherent in a given defence policy than of its essential advantages. And the Opposition unashamedly encourages it in this direction.

The V-bombers are the instruments of the policy of deterring a would-be aggressor though the threat of nuclear reprisals. Picture shows Avro *Vulcan* delta-wing bombers at RAF Station Waddington, Lincolnshire.



While ground-to-air missiles (such as the Bristol/Ferranti *Bloodhound* shown here) are designed for close-range defence, the English Electric P.1 jet fighter will be responsible for defence over greater distances. The P.1B in the picture above is armed with 30-mm cannon and de Havilland *Firestreak* infrared missiles.

In no country does public opinion understand that a strictly defensive policy can be based on round-the-clock flights by bombers armed with H-bombs. The man in the street simply does not realize that this is the only way to protect the reprisal potential, and prefers to believe that a *defensive* policy must of necessity make use solely of *defensive* weapons. Most people do not realize that there is not a single defensive weapon in existence today which is of the slightest use against the new offensive weapons.

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These then are the factors and the misapprehensions which the British Government faces in its efforts to construct a defence policy and procure the instruments needed to put it into effect.

Farnborough is not only the British aircraft industry's annual sales fair. The trained eye can also detect there the equipment which will be mentioned in future White Papers.

The now classic tasks allotted to the British forces are the following: 1) to hold a deterrent force in readiness; 2) to defend this force and, more generally, the British Isles; 3) to participate in the systems of collective defence for Western Europe, the Middle East and the Far East, and 4) to protect the overseas territories.

The deterrent

The V-bombers (*Valiants, Vulcans* and *Victors*) carrying nuclear weapons constitute the force designed to deter a potential aggressor through the threat of reprisals. The 1957 White Paper announced that the Government had decided against producing a supersonic bomber, which could not be put into service within ten years. Meanwhile medium and long range air-to-surface missiles (stand-off bombs) would be used to give a new lease of life to the four-engine Mach 0.9 bombers, which the White Paper implied would be Britain's last manned bombers. But high-altitude attack will become more and more difficult, even if the subsonic carrier aircraft can launch their missiles at a distance from their targets and turn back to avoid the enemy's defences. On the other hand low-level penetration, even at subsonic speeds, offers sufficient advantages to justify a new programme of offensive aircraft. The line of reasoning pursued was probably roughly as follows: as the deterrent concept is designed to hold over a potential aggressor's head the threat of nuclear reprisals against his cities, the degree of accuracy required is relatively low. In other words, the combined aircraft and missile error can be accepted. But when it comes to the capacity to attack pinpoint targets by the Low Altitude Bombing System, the suitably reinforced *Valiant* would not have the necessary range—and low-level attack is the only form which provides a degree of protection for the bomber and at the same time enables the crew to pick out targets which are too small to be detected by radar.

For the deterrent mission the V-bomber force will be backed up by ballistic missiles. The first generation of the latter will be American weapons, of the *Thor* type. An Anglo-American communiqué published on February 24th last stated that these missiles would be operated by British personnel, but that the nuclear warheads would remain the property of the U.S. Government and under its control. When and how the weapons should be used would be decided jointly by the two governments. This solution has many advantages. It in no way reduces the efficacy of the deterrent, since reprisals continue to be probable, and this very probability suffices to discourage any potential aggressor from running the risks inherent in launching an attack. The same reasoning holds good on a different level for the Mach 0.9 bombers. If there is the slightest chance that even a very small number could reach their targets, nobody will run the risk of deliberately provoking their dispatch.

The second generation of ballistic missiles will be British. The 1958 White Paper reveals that such a missile is under development on the highest priority and is designed for launching from underground. This would mean that an enemy would have to "consume" a very large number of missiles to neutralize them. Perhaps for a third generation invulnerability will be sought not by underground launching but through mobility, by using submarines as carriers, as for the *Polaris*.

Defending the deterrent

On the subject of the air defence of the deterrent force and of the British Isles as a whole, the 1957 White Paper envisaged that fighter defences should eventually be scrapped ("Work will proceed on the development of a ground-to-air missile defence system, which will in due course replace the manned aircraft of Fighter Command.") Meanwhile, however, the Government appears to have had second thoughts. The 1958 White Paper is explicit: "Following upon the decision, announced a year ago, that it was not practicable to attempt to defend the country as a whole against nuclear attack, Fighter Command now has the more limited task of protecting the bomber bases; and its strength is being correspondingly reduced. When the Russians, in addition to manned bombers, have ballistic rockets in sufficient numbers, capable of knocking out airfields in Britain, the value of a fighter defence system will obviously decrease; and the same will apply to a missile defence system, effective only against aircraft. But that point has not yet been reached. Meanwhile, the squadrons of

Fighter Command will continue to play their part in defending the deterrent." The future IRBM reprisal force will be protected by passive measures, such as placing storage and launching bases underground, or by increasing mobility.

As for defence of cities in the British Isles, this will be primarily indirect. Nevertheless, since the aggressor's task must always be made as complicated as possible and the general public must be given the impression that something is being done to protect them, the maximum use will obviously be made of ground-to-air missiles for close-range defence and of P.1 twin-jet fighters for defence at greater distance. Thus an attacker would be obliged to muster a large force of high-performance carriers. But in reality, cities will be protected to a much greater extent by indirect means than by direct. That is to say, the main object will be to prevent attack through the threat of reprisals, rather than to seek to minimize the effects of an attack if it should take place.

The NATO commitment

The third mission, namely participation in the system of collective defence for Western Europe, will continue to be performed in two ways. Firstly, Britain—like the United States—places her nuclear deterrent at the disposal of NATO. Secondly, London maintains conventional forces in Germany. The task of these British units is, in conjunction with other Allied contingents, to counter hostile actions of limited scope. Thus a would-be aggressor knows that he can achieve nothing with a small-scale attack and that any large-scale action will attract nuclear reprisals. In other words, the conventional units are again backed up by the deterrent force.

Support of the ground forces is one of the air units' prime tasks in any theatre of operations. Such tasks can also be performed by carrier-borne aircraft, such as the de Havilland *Sea Vixen* shown above with 24 three-inch rockets and cannon.

De Havilland *Comet 2* jet transports bring up shock troops, while the Blackburn *Beverley* is designed primarily to carry heavy supplies.

The size of Britain's contribution to NATO's conventional forces has been the subject of much outspoken discussion between London and SHAPE. London would like to reduce the manpower strength of its contingents, though at the same time increasing their firepower, eventually by means of low-power nuclear weapons. On the other hand, SHAPE recognizes a borderline, political if not military, between conventional and nuclear weapons, a borderline which should not be crossed too easily. The air units in this conventional force still use "old-fashioned" equipment, but the British Government appears to believe that the time is not far distant when nuclear warheads can be used in all kinds of carrier vehicles and manned aircraft can be replaced.

*

Overseas defence — an immediate problem

The authors of the 1958 White Paper admitted frankly that strategic bombers, supersonic fighters and atomic missiles are of little use in defending such places as Aden or Kuwait. "For these tasks, which represent a large part of the present responsibilities of all three Services, conventional forces equipped with non-nuclear weapons are required. A high proportion of Britain's military effort will therefore, of necessity, continue to go into forces of this kind." Meanwhile the British trade press is urging the procurement of more *Britannias* for RAF Transport Command, plus *Canberra 8s* or *Hunters* for local operations pending the production of new manned aircraft for this work... The light strike fighters designed to the SHAPE specification do not appear to have made a very great impression in Britain, though they may perhaps be taken more seriously tomorrow.

An interesting development in the field of defence against local outbreaks is the Pentagon's creation of the Strategic Army Corps (STRAC), whose mission is to dissuade a potential adversary from indulging in small-scale aggressions.

For this kind of task lightweight strike equipment is required, capable of operating from hastily prepared fields and demanding only a simplified logistics system. The greater the tension in the Middle East, the more urgent becomes the need to advance from projects to production.

The Versatile Gnat

The Folland *Gnat* can carry a large variety of outboard loads and is therefore suitable for many different combat tasks: 500-lb. bombs, drop tanks (each containing 55 gallons), 3-in. rockets or Type T.10 rockets. If required, one of the drop tanks can be replaced by a camera pod, in which three cameras are installed for reconnaissance purposes.

Production of the *Gnat* at Folland's Hamble factory. Above, assembly and equipment of fuselage; below, wing production. The *Gnat Mk.1* is at present in production at Hamble for India and Finland. Moreover work has commenced on a two-seat *Gnat Trainer*, fourteen of which have been ordered for the RAF under a pre-production contract.

The *Gnat 1* fitted with radar nose as ordered by the Indian Air Force and to be built under licence in India.

After battling for years against prejudices or outright opposition to his *Gnat* design, W. E. W. Petter, Managing Director and Chief Designer of Folland Aircraft Ltd., can now claim the satisfaction of booking orders and signing licence agreements for this lightweight strike fighter and interceptor.

At the Folland factory at Hamble, near Southampton, single-seat *Gnat Mk.1* light strike and interceptor aircraft are on the line for Finland and India; also Hindustan Aircraft Ltd., India, and Valmet OY, Finland, are to produce the aircraft under licence. Moreover the Jugoslav Government has already placed an order for two single-seat *Gnat 1s*, which will undergo evaluation trials to decide whether a production contract will be placed or licence production undertaken. Meanwhile very valuable experience has already been gained from the six *Gnats* ordered for trials by the Ministry of Supply.

In addition to this, the first *Gnat Trainer*—a two-seat version—is beginning to take shape in the jigs at Hamble, to meet the Ministry of Supply's pre-production order for fourteen aircraft intended for the RAF. Several other countries are also interested in the trainer version of the *Gnat*.

Compared with the original single-seat version—the *Gnat 1*—the two-seat trainer incorporates a number of modifications (increased wing area, outboard ailerons on the wings, 7 percent thickness/chord ratio) which fully meet the landing case for Flying Training Command's runways. A good deal of new engineering work has had to be done on the Trainer, and Shorts of Belfast have assisted with the wings. The *Gnat Trainer* will be flying in 1959 and will come from the outset from production jigs. With the political tension in the Near East, the *Gnat Mk.1* itself is now arousing considerable interest at the Air Ministry as a strike replacement for the *Venom*. It is possible that the outcome may be a substantial order for a pure light strike fighter version of the single-seat *Gnat*. In Aden, where it competed with the *Hunter* and *Jet Provost*, the *Gnat* proved itself capable of operating under the worst extremes of heat and rough airfields; what is more, a minimum of maintenance equipment was necessary. For example, under normal conditions it requires 750 and 600 yards respectively for the take-off and landing runs; the take-off distance at maximum all-up weight to 50 ft. (sea level) is 1,200 yards—under tropical conditions 1,375 yards. Use of the braking parachute reduces these distances by approximately 200 yards. The aircraft's radius of action is approximately 250 miles, and maximum endurance approx. two hours.

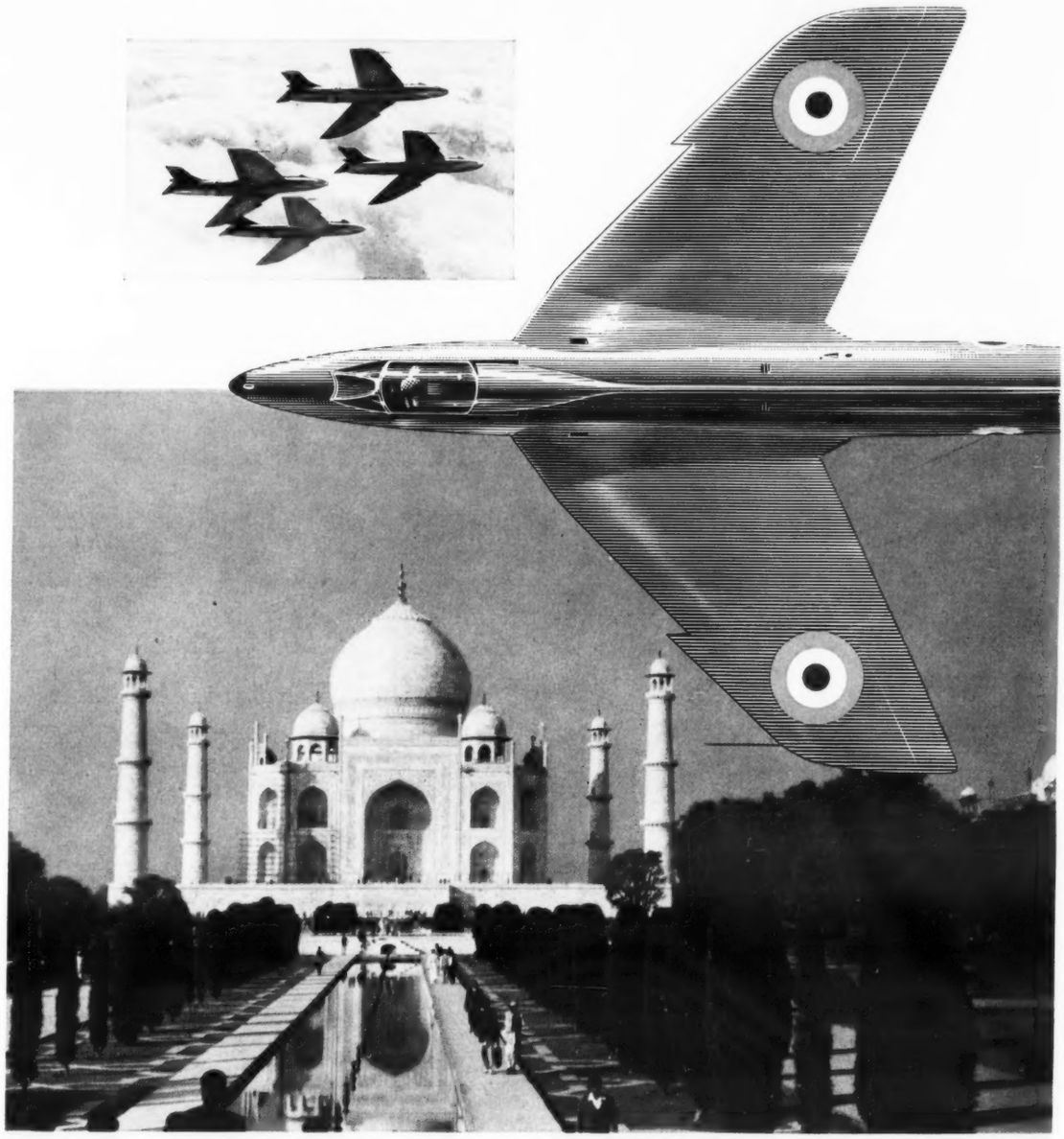
From the Mk.1, Follands have evolved the next step, the *Gnat 2*, capable of Mach 1.3 and exceptionally high rates of climb. This aircraft will have a reheat *Orpheus* powerplant and a 6 percent wing, and can be fitted with either *Firestreak* or *Sidewinder* guided weapons; advanced radar and fire control gear will also be installed. The Indian Air Force may decide later to produce *Mk.2s* at Bangalore, while the Jugoslav Government is also likely to buy and licence the Mk.2.

Follands can now obtain their supersonic performance on the *Gnat 2* without waiting for the bigger *Orpheus BOr.12*, which would also have meant a larger diameter rear fuselage.

While the *Gnat* will be Folland's bread and butter for years to come, the team at Hamble are also looking to the future on the light transport side.

Hunters Defend INDIA

Speed, offensive power and great versatility have given the Hawker Hunter pride of place in the air forces of many countries, including India. Today several squadrons of Hunters are in service with the Indian air force, forging another sturdy link in the defences of the free world. Hunters are also in service in Sweden, Denmark, Holland, Belgium, Peru, Iraq – and now Switzerland.



HAWKER AIRCRAFT LIMITED, Kingston-on-Thames, England

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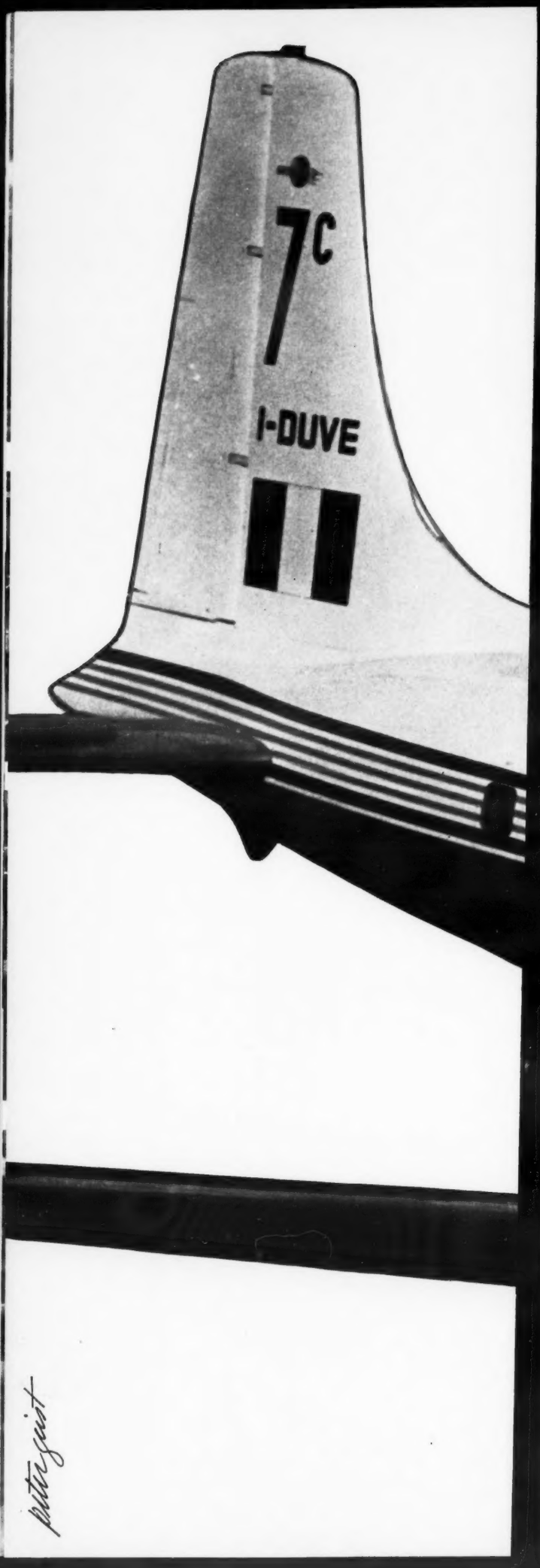

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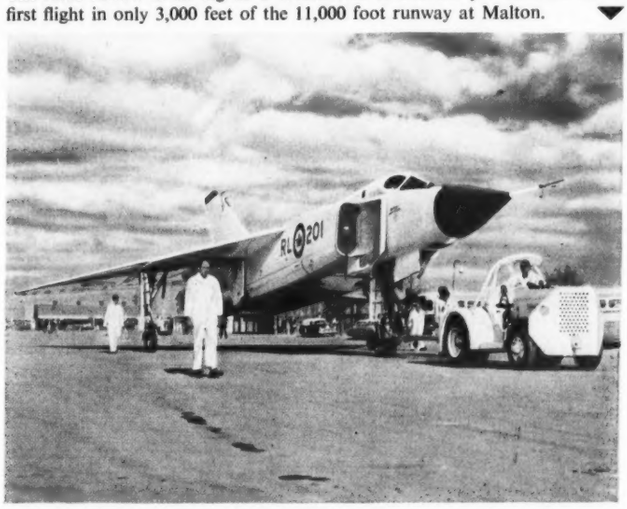
SERVING FIVE CONTINENTS

▲ The Avro Arrow is shown in flight during test manoeuvres over Ontario.

The Arrow weapon system is a bomber-destroyer having supersonic mission capabilities. ▼

The Avro Arrow is as big as a World War II bomber yet took off on its first flight in only 3,000 feet of the 11,000 foot runway at Malton. ▼



AN ARROW IN THE SKY

Since its first flight on March 25th, the Avro Arrow has been meeting the vigorous demands of its extensive flight test program. Proceeding according to plan, the Arrow flew faster than sound on its third flight, and more than 1,000 miles per hour on its seventh flight.

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The Hawker Hunter and the Ground Attack Role

By A. W. Bedford AFC, A.R.Ae.S. Chief Test Pilot, Hawker Aircraft Ltd., Dunsfold, Surrey

In spite of the nuclear deterrent, serious actions have occurred in Korea, Malaya, Suez and Oman which indicate the continued importance of certain conventional manned aircraft, among which the close support ground attack fighter, with an interceptor and reconnaissance capability, plays a significant part. Unquestionably the close support role requires its own specialised aircraft—if possible with VTOL or at least STOL capability—but until money is available and one is ordered it will be necessary to fill the gap with a proven aircraft already in production*. The following represents a survey of present attack problems and how they have been tackled on a typical standard fighter—the *Hunter*.

The Hawker *Hunter F.Mk.6* was designed from the start not only as an interceptor but also as a ground attack fighter, and as such each aircraft in service has as standard the facility to carry a large variety and quantity of external stores including long-range tanks, bombs, rockets, napalm, etc. Furthermore, these stores have been comprehensively tested and proved over the past four or five years and are all cleared up to the maximum "g" conditions for the clean aircraft and supersonic speed.

• **Armament:** In addition to its bombs and rockets, the interchangeable *gun pack* incorporating 4×30 mm cannon gives the aircraft the heaviest fixed gun armament of any ground attack fighter in the world, with the ability to deliver some 40 lb. in weight of ammunition per second. Ball, high explosive or incendiary ammunition may be used. Among the advantages of the interchangeable gun pack system are firstly the ability to rearm a spare pack while the aircraft is still airborne, thus facilitating an extremely rapid turn round time such that both refuelling and rearming can be achieved within seven minutes. Secondly, under tropical conditions the gun pack system avoids the necessity inherent in the handling of H.E. ammunition of having to wait a considerable time for "cooling off" prior to rearming. Both these factors effectively reduce the number of aircraft required and so permit greater flexibility and economy of operation. As is known, gun firing tests constitute a major headache with fighter aircraft, and only after firing thousands of rounds of ammunition over several years does one get a fully cleared and reliable installation with gas concentration, trim change, engine surge and ammunition heating problems completely solved. Gun firing on the *Hunter* has involved firing over 60,000 rounds of ammunition at maximum speed and low altitude.

• **Wing Section:** The *Hunter* was built to a requirement asking for an interceptor having a high subsonic level speed performance combined with good manoeuvrability at all altitudes. This automatically resulted in a moderately thick wing section, by modern standards, but one which therefore has very good "lifting" and low speed properties. These have been still further enhanced by the saw tooth loading edges which not only deal with the pitch-up problem but also improve control at the stall and lower the minimum touchdown speed.

• **Power:** Starting off with a good wing section is half the battle, but what about engine power? Compared with the *Mk.4*, the *Hunter Mk.6* introduced an extra 2,500 lb. thrust and combined surge-free handling with an attractive specific fuel consumption. Although this large increase in thrust made only a little difference to the level speed, it rejuvenated the take-off, acceleration, climb and turning performance by a marked improvement in the power/weight ratio, which under temperate conditions gave a take-off distance of some 950 yards even when carrying full ammunition, external fuel tanks and 24×3″ rockets.

• **Landing:** It is natural to associate an interceptor/ground attack aircraft with a large concrete strip—but is this entirely necessary? The length of run can be drastically reduced by the use of a tail parachute: on the *Hunter* a proven installation already exists and is fitted to Indian, Swiss and all two-seat aircraft. Furthermore, if with a drag chute the ground run on landing of some 600 to 700 yards is considered excessive, nosewheel braking and improved main wheel braking could be used to effect a still greater improvement. An arrester hook can also be used in conjunction with a simple, cheap anchor chain/wire arrester gear for emergency conditions, and this has already been developed in the case of the *Hunters* for the Royal Navy.

Sample collection of the *Hunter F.Mk.6's* military loads, which can total 5,000 lb. for each sortie. Immediately ahead of the fuselage nose is the rapidly exchangeable gun pack and four rows of 30-mm ammunition; left and right are the large and small auxiliary fuel tanks, bombs of various sizes and napalm containers. In the rear, the arsenal of rockets, two Fairey *Fireflash* guided missiles (inboard) and missiles of an undisclosed type (outboard); in the foreground the four 25-lb. practice bombs together with carriers.

* It has already been reported that Hawker Aircraft are working on an advanced design for a VTO light strike aircraft using a new type of combined straight jet lift/thrust engine – Ed.

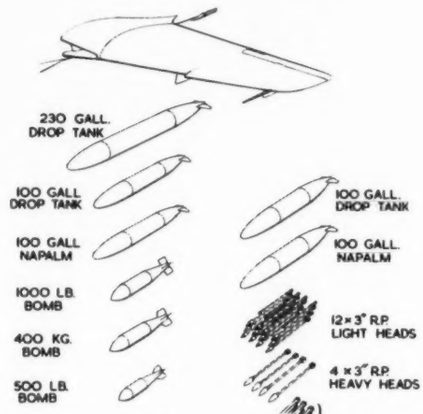
Hunter F.Mk.6 armed with 36 × 3-inch rockets (in four clusters of 12 or 6 rockets) and four 30-mm cannon . . .

. . . or carrying four auxiliary fuel tanks (660 Imp. gallons) for long-range penetration. (The pack for the brake parachute can be seen above the jet pipe.)

High pressure tyres demand hard surfaces but nevertheless, if there is a requirement to operate extensively from semi-prepared strips, what can be done to adapt an existing aircraft? Schemes utilising different tyres to drop the pressure initially by some 70 lb./sq.in. and latterly by 120 lb./sq.in. already exist. Even using standard tyres, *Hunters* are regularly flown at maximum all-up weight on delivery flights from the United Kingdom to India via the sand strip at Sharjah (Trucial Oman) in the Persian Gulf. The aircraft has also on occasion landed and taken off from a grass airfield in Britain.

With all jet aircraft operating on unprepared strips, stones and other foreign bodies have to be seriously considered, as there may be a risk of these entering the intake and damaging the engine. The problem is not only affected by the height of the nosewheel from the ground, but also by its geometry in relation to the intake. The trouble can be minimised by careful design of a suitable deflector plate aft of the nosewheel. The spray pattern from the nosewheel when taking off on wet runways gives a clue to the possibility of picking up stones, and to date no evidence exists to suggest that the *Hunter* is likely to be a bad offender. Additionally, on the *Avon* engine the blades of the first three rows of the engine compressor are made from steel, which enables small objects to be digested without damage.

• **Tropics:** It has been suggested that high temperature conditions will severely affect the aircraft's runway performance; the actual increases in ground run based on flight tests at near maximum all-up weight are 100 yards on landing and 250 yards on take-off. This is at a temperature of +45°C (113°F) as compared with the standard ICAN of +15°C.


230 GALL. DROP TANK
100 GALL DROP TANK
100 GALL. NAPALM
1000 LB. BOMB
400 KG. BOMB
500 LB. BOMB
200 KG. BOMB
37 or 24 2" R.P. POD
6×3" R.P. CARRIER
25 LB. PRACTICE BOMBS
100 GALL. DROP TANK
100 GALL. NAPALM
12×3" R.P. LIGHT HEADS
4×3" R.P. HEAVY HEADS
OERLIKON H.V.A.R. T.10 BOFORS & OTHER R.Ps
HAWKER HUNTER F. MK. 6 EXTERNAL STORES

The *Hunter F.Mk.6* can carry any combination of the external loads shown here.

• **Range:** In these days mobility and flexibility of operation are vital if rapid fighter reinforcement is to be possible, and in line with this requirement the aircraft has carried up to 660 gallons of external fuel. This permits extreme ferry range or a long penetration strike sortie with 4×30 mm cannon. Retaining either 2×100 gallon or 2×230 gallon drop tanks inboard, the outboard station then becomes available for rockets, rocket batteries, bombs, napalm, etc. One single aircraft is capable of carrying a total military load of the order of 5,000 lb.

• **Strength:** Particular attention has been paid to the structural strength of the aircraft; and over and above normal static tests which were extremely satisfactory, fatigue life checking by RAE Farnborough which involved many thousands of continuous applications of the maximum positive and negative "g" at 30-second intervals were carried out with results that were outstanding for this type of aircraft and indicated an exceptionally good fatigue life.

• **Manoeuvrability:** Extreme manoeuvrability, combined with short take-off and landing at maximum weapon load was an essential requirement during the 1957 Swiss evaluation of the *Hunter*. Particular attention was paid to turning performance, and having once determined this, the minimum radius of turn was extensively and convincingly demonstrated in rugged mountainous country. The aircraft was finally ordered after comprehensive armament performance measurements against French, Canadian, American and even the indigenous Swiss design specially prepared for alpine conditions.

• **Ejector Seat:** High or low level escape facilities are even more vital in ground attack operations; throughout the speed range this is assured by the Martin-Baker fully automatic seat which inspires confidence and keeps aircrew morale high because of its proven characteristics from 55,000 ft. down to ground level.

• **Development:** If a new military aircraft is to be a success, it is always a much longer, uphill and more expensive struggle than was originally visualised and may involve five or six years of development work and service knowhow before it is finally and fully proved. The *Hunter* was no exception but it now emerges having benefited from comprehensive testing at the Aeroplane & Armament Experimental Establishment, continuous design and development work, and service experience and operation with no fewer than nine air forces: RAF, Sweden, Denmark, Holland, Belgium, Switzerland, Peru, Iraq, India.

A gunnery range in the Swiss Alps, where the *Hunter's* exceptional manoeuvrability was demonstrated: approach from the right over the ridge in the centre, a salvo from all guns, turn away to the left . . .

The Westland Westminster

The first prototype of the Westland *Westminster* heavy helicopter has been undergoing flight testing under Chief Test Pilot W. H. Sear since June 15th, 1958. Two fuel tanks (capacity 250 Imp. gals. each) can be discerned in the centre of the unenclosed steel tube fuselage, and the two Napier *Eland E.229* gas turbines above the fuselage; fuselage length 70 ft.

The prototype of Britain's first large turbine-powered helicopter, the Westland *Westminster*, has been undergoing flight tests at Yeovil, Somerset, since June 15th, 1958. Unlike its closest rival, the Fairey *Rotodyne*, which in cruise operates partly as an autogyro and partly as a fixed-wing aircraft, the *Westminster* is a "pure" helicopter, an interesting adaptation of the United States' Sikorsky S-56 model (with two piston engines) to gas turbine power.

The *Westminster* prototype's powerplant consists of two converted Napier propeller turbines of the *Eland E.229* type, mounted side by side and each delivering a take-off power (derated) of 2,400 s.h.p. or an emergency rating of 2,920 s.h.p. They differ from the normal *Eland* turboprop in the absence of the propeller reduction gears at the front of the engine and the addition of a new shaft drive at the rear, behind the three-stage turbine rotor and angled exhaust pipe. The extended main shaft of each engine acts via a hydraulic clutch on an individual reduction gear and free wheel unit, and the free shafts in turn drive a common (third) reduction gear which turns the large five-blade rotor at a normal speed of 178 r.p.m. and the tail rotor at 870 r.p.m. Thanks to the hydraulic clutches (which have a 2% slip at maximum torque) and the free wheel units, the power required to turn the rotors is taken in equal shares from the two turbines, even when the latter operate at differing speeds. In an emergency the full power requirement can be supplied by one engine. The hydraulic oil is cooled by a fan installation.

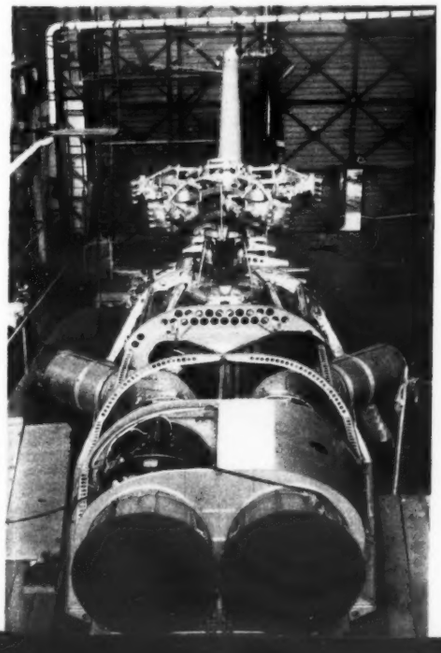
In the production model of the *Westminster*, Westland plans to replace the prototype's *Eland E. 229* by modified *Eland NEl.6s* of 3,150 s.h.p. take-off power and 3,650 s.h.p. emergency rating. Planned production types are a "flying crane" version for 14,000 lb. payload and a transport version for 46 passengers: gross weight 36,000 lb. in the former case, 33,000 lb. in the latter.

The *Westminster* uses the same proven main rotor (diameter 72 ft.) as the S-56, and the same flying controls. As the turbine engines have very much more modest cooling requirements and are simpler to install than piston engines, it has been possible to dispense with the S-56's high-set stub wing, which is more of a hindrance than a help in pure helicopter flight. The engines are therefore mounted on top of the fuselage. The prototype has an open steel tube fuselage, but the production model will have a light-metal monocoque fuselage.

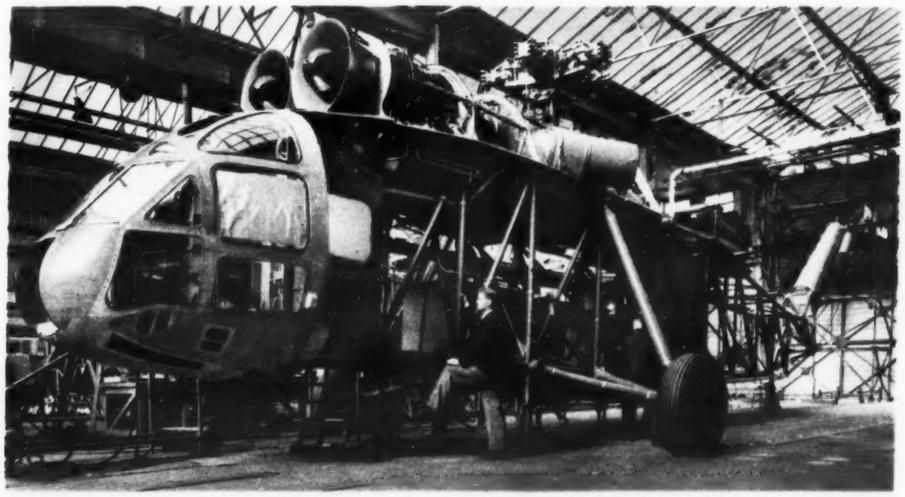
Westland and Napier both point out that the installed weight of the turbine engines is roughly 25% lower than that of piston engines in the same power class. This advantage greatly improves the helicopter's carrying capacity over short stages. Over longer distances, however, the turbines' higher specific consumption may be a drawback, but only when the engines are operated at greatly reduced power (e.g., 50%) and not at higher engine power (e.g., 80% of the rated power) and in headwinds. Cruising speed of the transport version will be 150 m.p.h., and maximum range (with reduced payload) 400 miles.

The *Westminster* is the fifth British helicopter to result from the ten years of cooperation between Westland Aircraft Ltd. and the Sikorsky division of United Aircraft. Its forerunners were the *Dragonfly* and the *Widgeon* (derived from the S-51), both with Alvis *Leonides* helicopter engine, the *Whirlwind* (S-55, with American engines or Alvis *Leonides Majors*), and finally the *Wessex* (with Napier *Gazelle* free-turbine engine), an "anglicized" form of the S-58 medium helicopter.

The *Westminster's* two Napier gas turbines and five-blade, power-controlled rotor head. Behind the angled exhaust pipe of each engine lies a hydraulic clutch and a reduction gear. Final reduction of rev. speeds takes place in a third reduction gear, underneath the rotor head.



The propeller gears have been removed; the oil coolers (underneath the compressor intakes) have been retained. They cool the oil which has been heated by the hydraulic clutch slip and the friction of the three rear gears. The first pilot occupies the seat on the right, the second sits on the left. The wide-track undercarriage remains permanently in the air flow, which is acceptable in view of the helicopter's low cruising speed, and reduces airframe weight.



The Boeing Bomarc

A Pilotless Interceptor for Area Defence

The introduction of long-range bombers with near-sonic cruising speeds and operating altitudes above 50,000 ft., and the production of nuclear warheads capable of attacking all kinds of area targets have raised very serious problems for air defence in recent years. And the situation will become even more precarious with the availability of supersonic bombers and pilotless long-range missiles capable of penetrating deep into their opponent's territories within a few minutes, without giving the defence time to ascertain their probable targets. This growing threat from the air throws into even sharper focus the question of how, with a by no means inexhaustible defence budget, to create a defensive system to protect all strategically important areas—cities and industrial centres covering hundred of square miles—against all approaching A and H bomb carriers. Above all what kind of defensive weapons could successfully cordon off such large areas at the push of a button?

*

Shortly after the creation of the USAF Strategic Air Command's first bomber units, nearly ten years ago, the U.S. Air Force sponsored a complete reappraisal of air defence requirements. Boeing Airplane Company and the University of Michigan's Air Research Center were commissioned to conduct a systematic study of the air defence situation in the United States. After considering all the instruments of air attack likely to be available in the near future (with the exception of ballistic missiles) and special attention to the costs of the overall defence system, the investigators came to the following conclusions:

1. To be both effective and economic, the required defence system, using missiles, must be an *area system* designed to protect not a host of point targets but a number of area targets against attack by manned bombers or unmanned missiles.

2. This missile defence system must be capable of integration into a *wide-spread electronic warning and control system*, which could at the same time take over operational control of all other defence instruments (shorter range anti-aircraft rockets, all-weather fighters and interceptors). If an effective defensive system, deployed in depth, is required, the simultaneous employment of manned fighters and robot weapons must be expected to continue for a good many years.

Originally it had been generally believed that the defence of cities the size of Washington, New York, Chicago or Los Angeles would require the establishment of literally dozens of anti-aircraft missile batteries at each location. And even then vast hinterlands would be virtually unprotected. Any attempt to defend larger areas by means of surface-to-air missiles with an operating range of only 20 to 25 miles seemed to be impossible, both economically and technically. The study conducted by Boeing and the University of Michigan, however, revealed that automatic defence weapons of high firepower and something like ten times the operational range could provide the required area defence with only a small number of batteries, provided that a reliable long-range warning and control system were available. As such a warning and control system was already under development in the shape of SAGE (semi-automatic ground environment), the chief remaining problem was to design and produce the actual weapon.

In propounding the requirements for the missile system, analysts had to plan with two basic limiting factors in mind—one economic, the other technical. In most cases the two were contradictory. To be most economical a defensive missile should have infinite range. The ideal solution would be a concentration of missiles at one point, capable of reaching any other point. Although the missiles themselves would be expensive, their utility would be so great, the logistics so simple, and the manning, facilities and battle planning so simplified that the overall cost would be much lower. But from the technical viewpoint the development of such a weapons system presented formidable problems. At the other end of the scale, a weapon of point defence capabilities would be the simplest to develop, but its cost in relation to effectiveness would be high. What was the best compromise between these two extremes?

By 1950 Boeing thought it had found the answer. After firing some 112 ground-to-air vehicles at speeds of up to 1,500 m. p. h. and demonstrating "kill" probability at altitudes from 6,000 to 80,000 ft., after testing rocket engines and ramjets and experimenting with a variety of guidance systems, company engineers arrived at the following specifications for the new missile project:

- Constant operational readiness
- Vertical launching and acceleration to near-sonic speeds on rocket thrust
- Continued climb and target approach on ramjet power
- Range at least 200 miles (later increased to 250 miles)
- Ground fire control equipment to guide the weapon into the target area
- An autonomous radar system in the missile to seek out and lock on the target.

On the basis of these requirements the U.S. Air Force awarded a development contract in January 1951. The whole project received the designation IM-99 *Bomarc* (standing for Boeing and Michigan University Air Research Center).

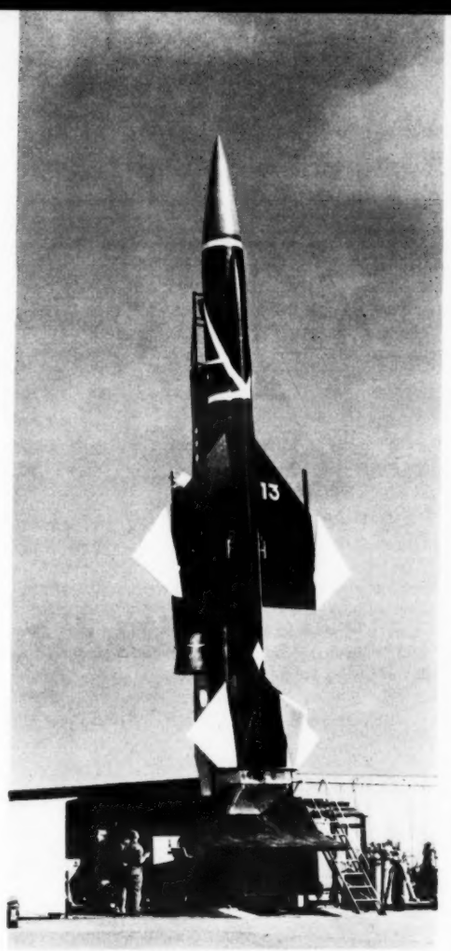
*

The size of the missile was largely dictated by the dimensions of the warhead and the quantity of propellant required to give it the necessary range. Originally a purely high explosive warhead was envisaged, though later the requirement was issued to house an atomic warhead in the fuselage

Trio for North American air defence: the IM-99 *Bomarc* missile, flanked by Canada's CF-100 all-weather fighter (left) and the USAF's F-102A supersonic fighter (right), is shortly going into service with Air Defense Command to provide added strength for NORAD.

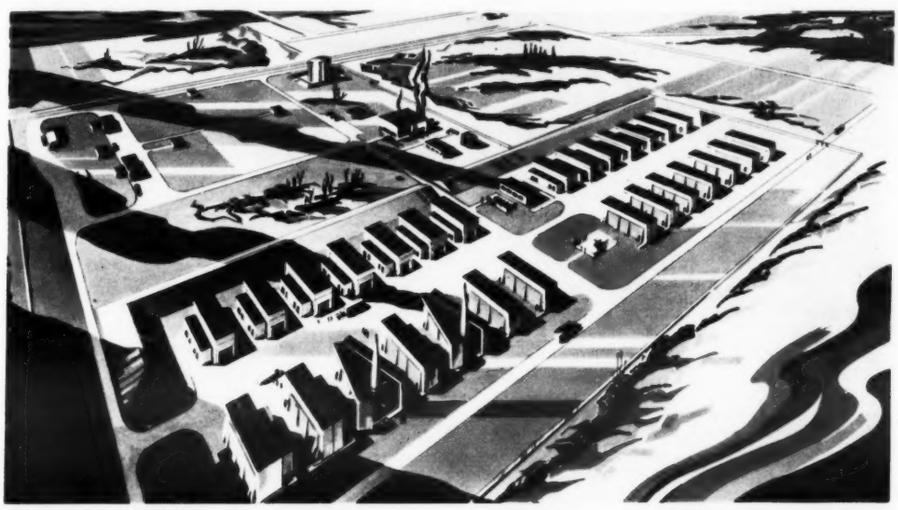
Leading contractors for the IM-99 Bomarc weapons system

Boeing Airplane Company, Seattle, Wash., (prime contractor for the whole system)	Missile airframe
Aerojet-General Corp., Azusa, Cal., (main subcontractor)	Boost rocket motors
Marquardt Aircraft Company, Van Nuys (main subcontractor)	Ramjets
Westinghouse Electric Corporation, Baltimore, Md. (main subcontractor)	Homing radar and control equipment
Other subcontractors	
American Gyro, Santa Monica, Cal.	Rate gyros
American Machine & Foundry Co., Alexandria, Va.	Weapon support equipment
Brunswick-Balke-Collender Co., Vashon, Wash.	Radomes
Blount Brothers Construction Co., Montgomery, Ala.	Weapon support equipment
Burns & Roe, Inc., New York, N.Y.	Ground support equipment
Farnsworth Electronics Co., Fort Wayne, Ind.	Operational test equipment and electrical launching equipment
Food Machinery & Chemical Corp. San José, Cal.	Weapon support equipment
Kaiser Metal Products, Inc., Bristol, Penna.	Fuel tanks
Lear Incorporated, Grand Rapids, Mich.	Coordinate converter and data link receiver
Librascope Inc., Glendale, Cal.	Transformer-rectifier
Minneapolis-Honeywell Regulator Co., Philadelphia, Penna.	Weapon support equipment
Motorola Inc., Phoenix, Ariz.	Guidance beacon and data link decoder
Radio Corporation of America, Los Angeles, Cal.	Radar
Telechrome Manufacturing Co., Amityville, L.I., N.Y.	Transmitters
Temco Aircraft Corporation, Dallas, Texas	Modification of B-57 for test purposes
Texas Instruments Inc., Dallas, Texas	Telemetering equipment
Thompson Products Inc., Cleveland, Ohio	Switches
Varian Associates Inc., Palo Alto, Cal.	Klystron tubes and transmitters
Whittaker Gyro, Division of Telecomputing Corp., Van Nuys, Cal.	Rate gyros



A Boeing *Bomarc* surface-to-air missile ready for launching at Patrick AFB, Florida.

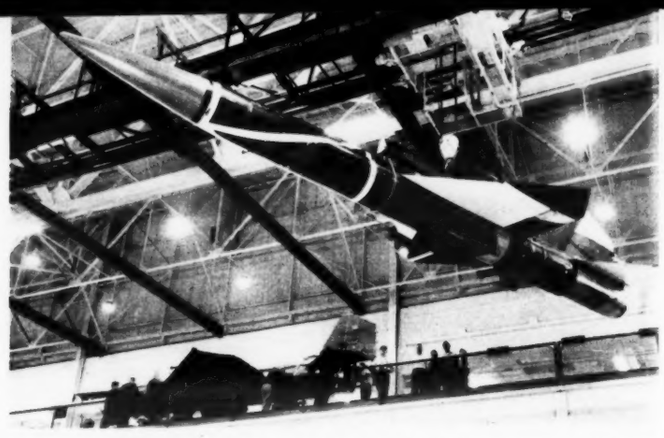
The vertical launcher falls away... and the *Bomarc* rises from the ground on the thrust of its booster rocket.



This *Bomarc* tactical launching site, to be used for operational testing of the entire weapons system, is being built near Eglin AFB, Florida. As at the operational bases now under construction, the *Bomarc* missiles and their launching rigs are housed in small hangars, which open automatically before launching.

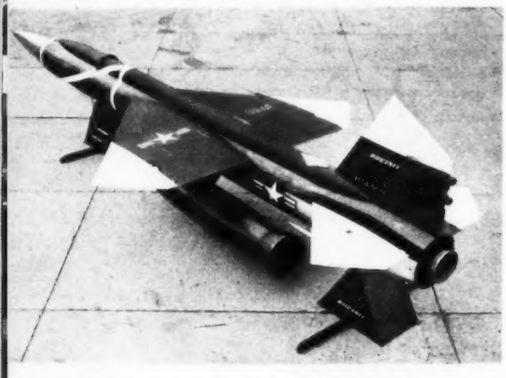
Normally the *Bomarc* rests horizontally on its cradle. As soon as an alert is received, the cradle is erected, when the rear of the missile body rests on a small launching pad. The cradle then swings through some 45°, leaving the missile free for launching.

A few hours before a test firing at Patrick AFB a *Bomarc* is filled with nitric acid for the rocket motor; for this task the crews wear protective rubber and plastic suits.



A completed IM-99 *Bomarc* being lowered from the production balcony to the main factory floor at Boeing's Seattle plant. After ground testing, the two ramjets and the nose cone will be removed and transported separately to the base.

Bomarc tail with gimballed rocket motor.



Engine layout... wing and tailplane planform.

of the ground-to-air-missile. Weight of the extensive electronic equipment was reduced to a minimum by systematic miniaturization, so that the finished weapon (length approximately 47 ft., wing span about 18 ft.) could be held to a total weight of less than 15,000 lb. Although wing and tailplane planform and the arrangement of the power units were changed several times during the first project stage, dimensions and weights remained virtually unchanged throughout development.

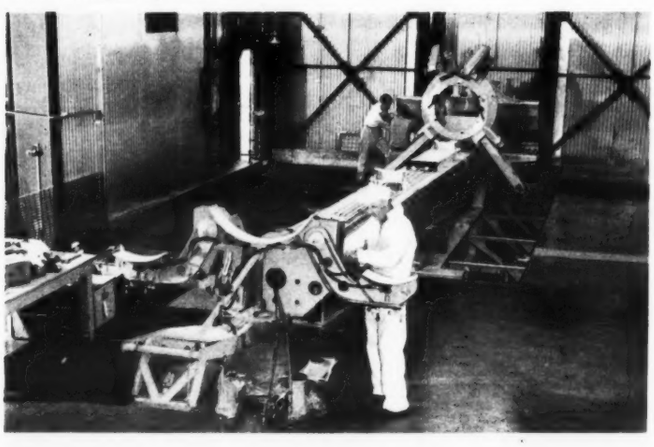
The first prototype, fired at the Cape Canaveral Missile Test Center on September 10th, 1952, had no ramjets installed and was powered solely by the liquid-propellant rocket engine on a gimbal mounting at the rear of the fuselage. Development of the ramjet units took more time, and it was not until after further basic research and extensive testing with the Lockheed X-7 experimental vehicle that the difficulties encountered could be overcome. Meanwhile first launchings with the *Bomarc*, using rocket power only, had proved that the vertically rising missile could be stabilized and controlled by swivelling the whole rocket combustion chamber. At any rate, the launching phase, particularly critical in the presence of sharply varying ground winds, was tested to the designers' full satisfaction, and Boeing still is proud of the fact that the *Bomarc* was one of the first missiles to be operated successfully on a gimballed rocket engine. The decision to launch the *Bomarc* vertically was probably based on the consideration that the rapid changes in centre of gravity and stability as the rocket engine propellant is consumed can be most easily controlled with the fuselage in vertical attitude. Once higher speeds have been reached, the aerodynamic surfaces on the wing and tail tips become effective and enable accurate flight manœuvres to be carried out with tight turns, particularly at supersonic speeds.

One of the most distinguishing features of the *Bomarc* is its conical fibreglass nose (length more than 8 ft.) covering the Westinghouse target seeking radar in the forward portion of the fuselage. Before this radome is accepted it is tested with interferometers to ensure the outmost accuracy and prevent distortion of the radar image. Behind the target seeker is the airborne portion of the guidance system, also produced by Westinghouse. In essentials, this equipment includes a receiver for command signals from the ground and equipment to transform these signals into control impulses. During the initial flight phase, when the missile is not guided from the ground, the airborne guidance system provides a special climb pattern. Immediately behind the guidance equipment is the space for the warhead; for the test launchings this space was used to house measuring and telemetering equipment. Most of the rest of the slender, cylindrical body is taken up with fuel for the ramjets (80-octane gasoline) and the rocket engine (a combination of JP-4 and unsymmetrical dimethyl hydrazine, with red fuming nitric acid as oxidizing agent). The walls of the fuel and propellant tanks at the same time form the fuselage skin, so that the complete airframe, including the extremely thin wings, is particularly light in weight. Electrical and hydraulic leads are carried in a special bulge on top of the fuselage.

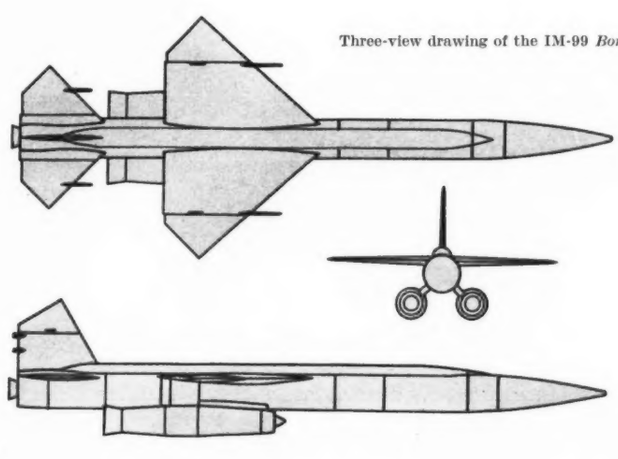
The delta wing, mounted on the fuselage, has a leading edge sweep of 50° and a thickness/chord ratio of roughly 3%. The whole truncated tips can be swivelled about a central axis and thus act as ailerons. The elevators and rudder are of the same geometrical configuration and are extremely efficient in the supersonic speed range (the angles of the control surface trailing edges are greater than half the angle of the Mach cone at full design speed).

Two Marquardt RJ43 ramjets are suspended side by side on short pylons underneath the

A *Bomarc* launcher being installed in a missile shelter. In the foreground the nose clamps, and at the far end of the erector boom are restraining arms to hold the missile vertical during heavy winds.



Three-view drawing of the IM-99 *Bomarc*.



fuselage. Each has a fixed conical inlet diffusor and an overall diameter of approx. 27 ins. At the rear of the fuselage, finally, is the Aerojet rocket engine, which accelerates the missile to the speed required for the ramjets to take over. Apart from its vertical take-off, the *Bomarc* thus resembles a supersonic fighter with mixed powerplant, in which the pilot is replaced by a completely automatic guidance and control system. With the absence of a pilot (and of an undercarriage) it has been possible to create a robot missile weighing only 15,000 lb. and capable of speeds of above Mach 2.5, an operating range of some 250 miles and a degree of manœuvrability at all altitudes such as is unattainable in a manned fighter, because of the excessive physical strain it would impose on the pilot.

*

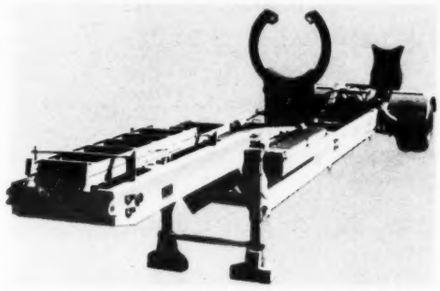
The success of a ground-to-air weapon, however, does not depend solely on its range, speed and manœuvrability. The *Bomarc* must be steered towards distant targets, then select one of them at the appropriate moment and destroy it on a collision course as far away as possible from its own launching base. How can a missile hurtling along at speeds several times that of sound be guided into the immediate vicinity of a target at a distance of some 200 miles? And what is the situation if forty of these missiles are launched simultaneously from the same base against different air targets?

As already indicated, the USAF began work in the early fifties on its SAGE radar warning and guidance system, which is designed to detect all enemy aircraft movements and constantly coordinate them—with the aid of electronic computers and storage equipment—with those of the defence forces. The SAGE system, now partly completed, enables all information on the situation in the air to be transmitted via communications lines to central and local air defence headquarters. Its memory units contain intimate, detailed knowledge of the availability and capability of all of the defensive weapons (manned aircraft, anti-aircraft guns and point defence and area defence missiles). SAGE computers in an instant can tell a commander just where he would be able to intercept the invader with any defensive weapon or combination of weapons under his control. As SAGE and *Bomarc* were developed at roughly the same time, the missile could be designed from the outset as a vital link in the United States' air defence system. The *Bomarc* can at all times precisely follow the instructions it receives from the SAGE centre and is automatically directed to the target area.

During the first phase of the *Bomarc* programme, however, SAGE was not much more than a concept on paper. Thus in order to test research and development versions of the weapon system, some smaller, more limited ground environment system was required. This was provided by Westinghouse Electric Corporation under the designation AN/GPA-35 and was used successfully in more than forty firing tests at Cape Canaveral. Although by no means as far-reaching as SAGE, the Westinghouse system can nevertheless be employed, together with existing radar, to control a substantial number of defence weapons in areas not covered by the SAGE system. For example, for coverage of an area like Western Europe, a number of AN/GPA-35s could be blocked together to provide coordinated defence. This would greatly increase the value of the IM-99 *Bomarc* to the West's overall defensive system.

In operation, the *Bomarc's* accuracy is greatly improved by the Westinghouse target seeking radar in its nose. As soon as the missile has been directed by ground control into the vicinity of the approaching enemy, the radar locks on the allotted target and sends control signals to the guidance system; from then on the ground signals are ignored. On reaching the immediate neighbourhood of the target, the warhead is detonated by a proximity fuze.

A full check of the *Bomarc* is made at Boeing's Seattle plant. Dummy ramjet engines are fitted to give the missile the same centre of gravity as the operational version. The weapon hangs from four leaf springs, leaving all control surfaces free for movement.

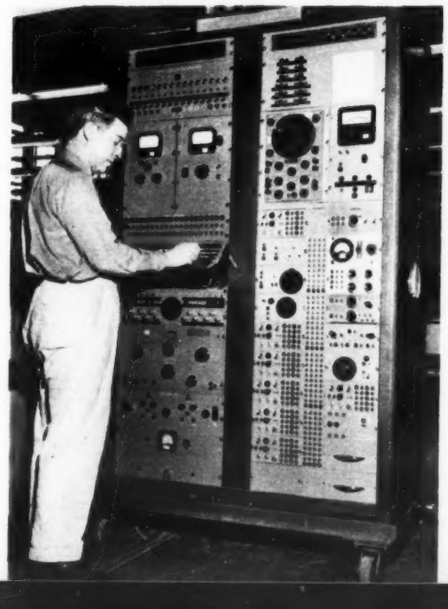


This trailer for road transport and a recently developed self-propelled launching rig make the IM-99 into a mobile weapons system if required.

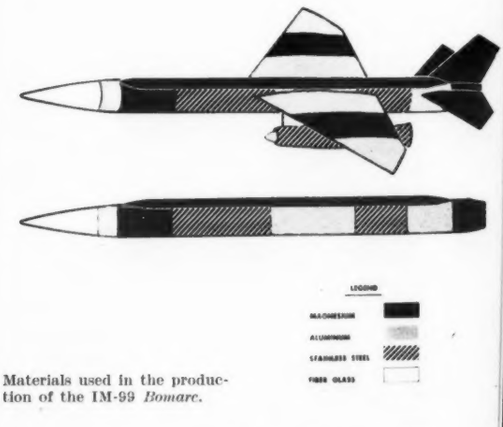
In order to obtain full benefit from the *Bomarc's* range capabilities, two other requirements had to be met: high traffic capacity, i. e., a large number of missiles would have to be launchable virtually simultaneously, and speed in launching. Even with a high traffic capacity, a given area can be fully protected only if each individual missile is allocated a specific target, a requirement which is fully met in the *Bomarc* weapons system. Similarly a large number of launching devices will be needed to ensure simultaneous launching—one rig for each of the missiles in a battery—as there will be no time for reloading the rigs. Every minute lost brings the enemy several dozen miles nearer to his target and robs the *Bomarc* of its most valuable asset, range. For the same reason provision had to be made for rapid warmup of the missile. The objective set was an ability to get the missile airborne within three minutes of an alert, but tests of the working missile and its ground equipment show that this can be done in two minutes. This result was achieved by designing special checkout equipment which keeps the missile at the ready day and night, by the use of electrical and electronic instruments with a short warmup period and by providing a launching rig which rapidly swings into firing position.

In use against an attack *Bomarc* would be alerted by the regional air battle commander. If he chooses to use *Bomarcs* to repel the attack he alerts as many as necessary at one or more bases simply by pushing a button, whereupon these missiles automatically prepare for launching within 120 seconds. As soon as they are warmed up they begin receiving second-by-second directions on their individual courses to predicted intercept points. These directions are evaluated constantly by the guidance system aboard the weapon until the fire command is given. If the command is issued to a missile before its 120-second warmup and erection period is complete, it will fire as soon as this cycle is finished. After the vertical climb phase each *Bomarc* is guided individually to its target, and even during the final attack phase (when control is provided by the target seeking radar) the missiles will not home on one another.

Although in principle the *Bomarc* could be affected during the ground-controlled phase by enemy countermeasures, in practice this risk is



Operational check-out equipment includes this cabinet with the aid of which a *Bomarc's* whole flight programme can be checked through on the ground.



Materials used in the production of the IM-99 *Bomarc*.

This test vehicle built under Boeing's GAPA (ground-to-air pilotless aircraft) programme ten years ago also had a delta-wing with tips cut off obliquely. The booster rocket, bearing four large guide vanes, and the main rocket motor were fired simultaneously.

The Westinghouse target seeking radar was tested by a Martin B-57 jet bomber, which was equipped for the purpose with the complete *Bomarc* radar nose and homed on to the most varied "air targets".

not of a high order, for three reasons. Firstly the missile is launched so quickly and is so soon racing towards its target that the enemy has little time to change his tactics. Secondly, its course to the target area is based on information from many ground sources, and it is highly unlikely that the enemy could jam them all. Thirdly, the nuclear warhead is so lethal that an attacking aircraft can be destroyed from a distance.

As already stated, *Bomarc* units will be incorporated into the United States' overall air defence system based on SAGE, so that they will use the same control system as the manned fighters or anti-aircraft rockets for point defence. This naturally reduces the cost of the new weapons system. The manufacturers state that a complete *Bomarc* unit, with missiles, special testing equipment, launching devices and maintenance equipment, is less costly than a manned interceptor unit on 24-hour alert, with its three pilots per aircraft, specially trained ground crews, maintenance installations, hangars, control tower and . . . miles of runway. The cost of one *Bomarc*, plus spares, produced in operational numbers is a little over $300,000, whereas an advanced Century Series fighter today costs considerably more than four times as much.

All missiles at a *Bomarc* base are periodically checked by mobile inspection equipment, which either indicates by a series of green lights that the missile is in operational condition or isolates the trouble spot by a flashing red light. The faulty component is not repaired on the spot but immediately replaced and sent to a major overhaul depot. Electronic system packaging has been designed in such a manner that a malfunctioning unit can usually be slipped out.

Boeing's supersonic wind tunnel at Seattle, inaugurated on October 30th, 1957, has been used to test *Bomarc* models at speeds corresponding to Mach 4.

Lysle A. Wood, Boeing Vice-President and General Manager, Pilotless Aircraft Division, and Colonel R. J. Walling, USAF Plant Representative, with the first production model of the new surface-to-air weapon.

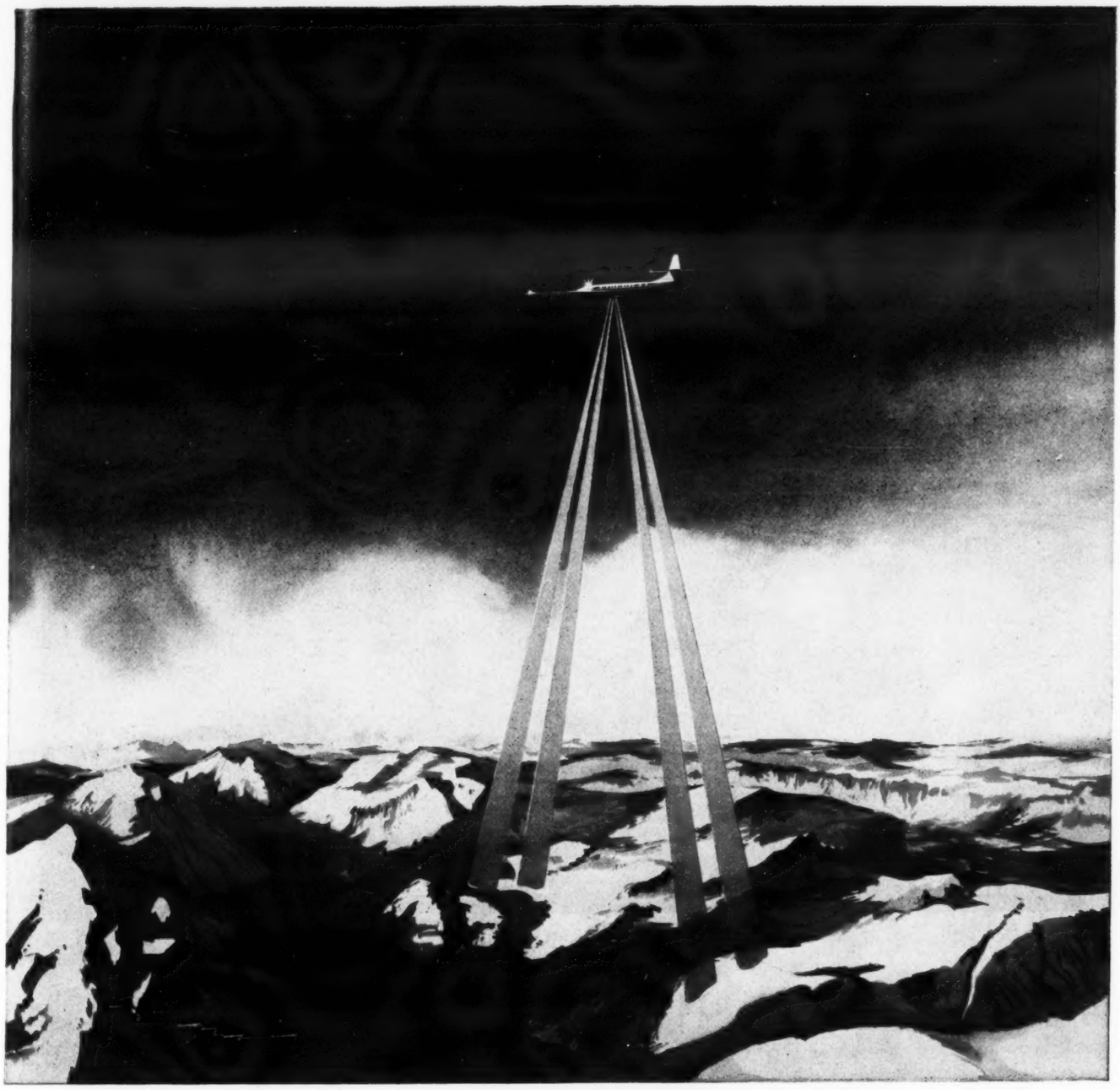
*

Boeing and its subcontractors have now been testing every part of the *Bomarc* weapons system for many years. For example, the target radar has been mounted in several manned aircraft, including a twin-jet Martin B-57, and checked in hundreds of simulated target approaches. Countless detail tests and some 50 test firings of the entire *Bomarc* system leave no doubt that the United States' first long-range anti-aircraft weapon for area defence has advanced to fully operational status. So far fourteen launching bases have been announced for construction in the United States. The first four are now being set up at Dow AFB, near Bango, Maine; McGuire AFB, near Trenton, N. J.; Otis AFB, near Falmouth, Mass.; and Suffolk County AFB, Long Island, N. Y.* Each base will cost between $10,000,000 and $13,500,000. Meanwhile a training base has been set up on the island of Santa Rosa, in the Gulf of Mexico, and the first *Bomarc* squadrons will be operational with the USAF's Air Defense Command by the end of the year.

Today Boeing is already working on new, even longer range versions of the pilotless interceptor. The *Bomarc B* under development has improved ramjets, which have recently been tested at speeds around Mach 4 and altitudes up to 100,000 ft. These engines will contribute to the extension of *Bomarc's* range to 400 miles, while substantially increasing speed and altitude capabilities. The liquid-propellant rocket booster at the rear will be replaced in the "B" version by a lighter solid-propellant Thiokol rocket engine, which will also occupy less space and thus enable a larger supply of fuel to be carried for the ramjets.

The *Bomarc B* will provide coverage up to 100,000 ft. for an area of over half a million square miles, or two and a half times the size of France, and thus seems likely to remain the leader in the air defence field for some long time to come.

* The other ten planned will be at Paine AFB, near Everett, Wash.; Camp Adair, near Albany, Ore.; Kinross AFB, near Sault St. Marie, Mich.; Travis AFB, near Sacramento, Cal.; Cooke AFB, near Lompoc, Cal.; Ethan Allen AFB, near Winooski, Vermont; Langley AFB, near Hampton, Va.; Niagara Falls AFB, N.Y.; Traux AFB, near Madison, Wis.; and a base near Duluth Municipal Airport, Minn.



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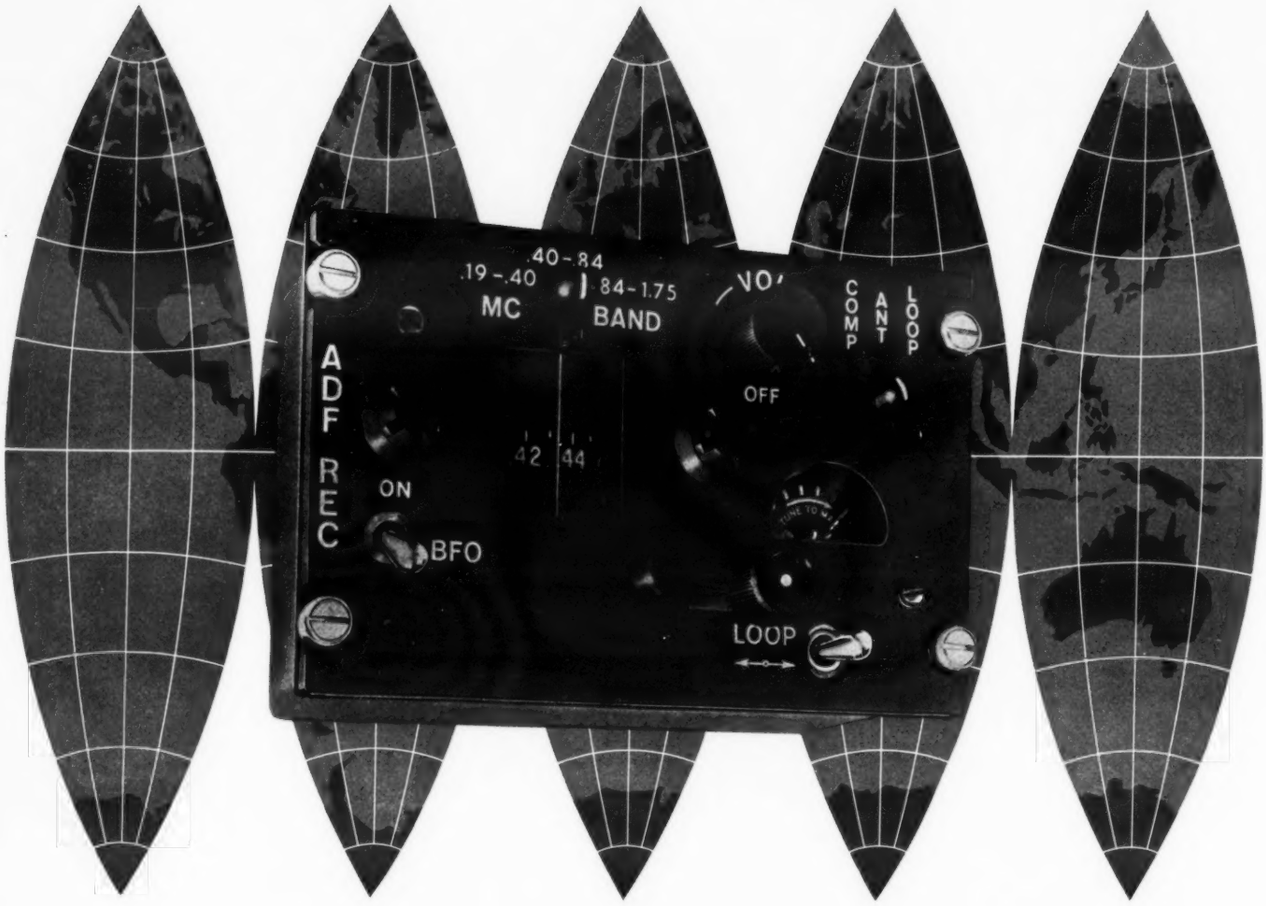

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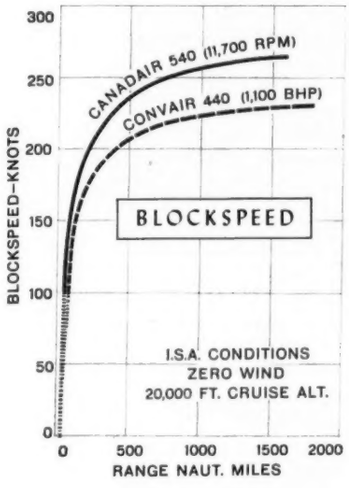
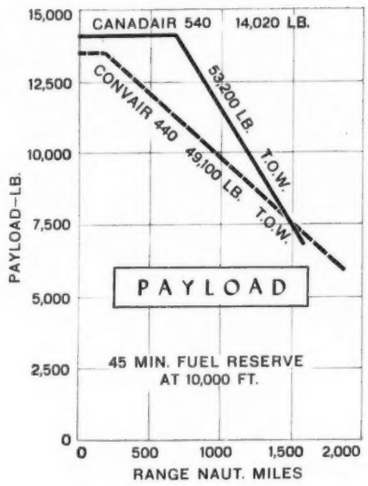


Graph at left shows the significant improvement in speed available in the turbine-powered "540" compared with the "440"—as much as 34 knots at a range of 1000 nautical miles.

Graph at right shows that the earning potential of the "540" is greatly increased. It is capable of carrying 48 passengers, plus their baggage, plus 4210 lbs. of cargo (total payload: 14,020 lbs.) a distance of 680 nautical miles. This represents a payload increase of 365 lbs. over the "440", and a range increase of 500 nautical miles.



Furthermore, with its Napier Eland turbine power, the "540"s max gross weight is increased 4100 lbs. over the "440" (up to 53,200 lbs.) . . . and the "540" can reach cruising altitude of 20,000 ft. in half the time (15½ mins. vs. 35 mins.). The "540" builds on the well-known and excellent record of the "440", and is altogether a new airliner unsurpassed in performance characteristics and earning power.

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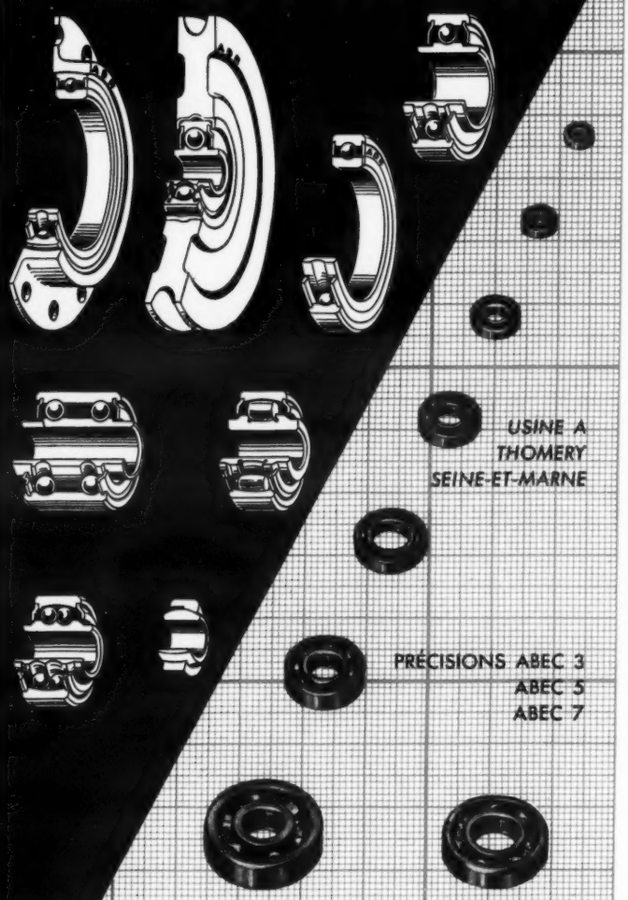

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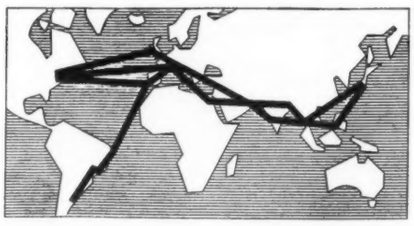

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The fares are all the same: it's the service that's different

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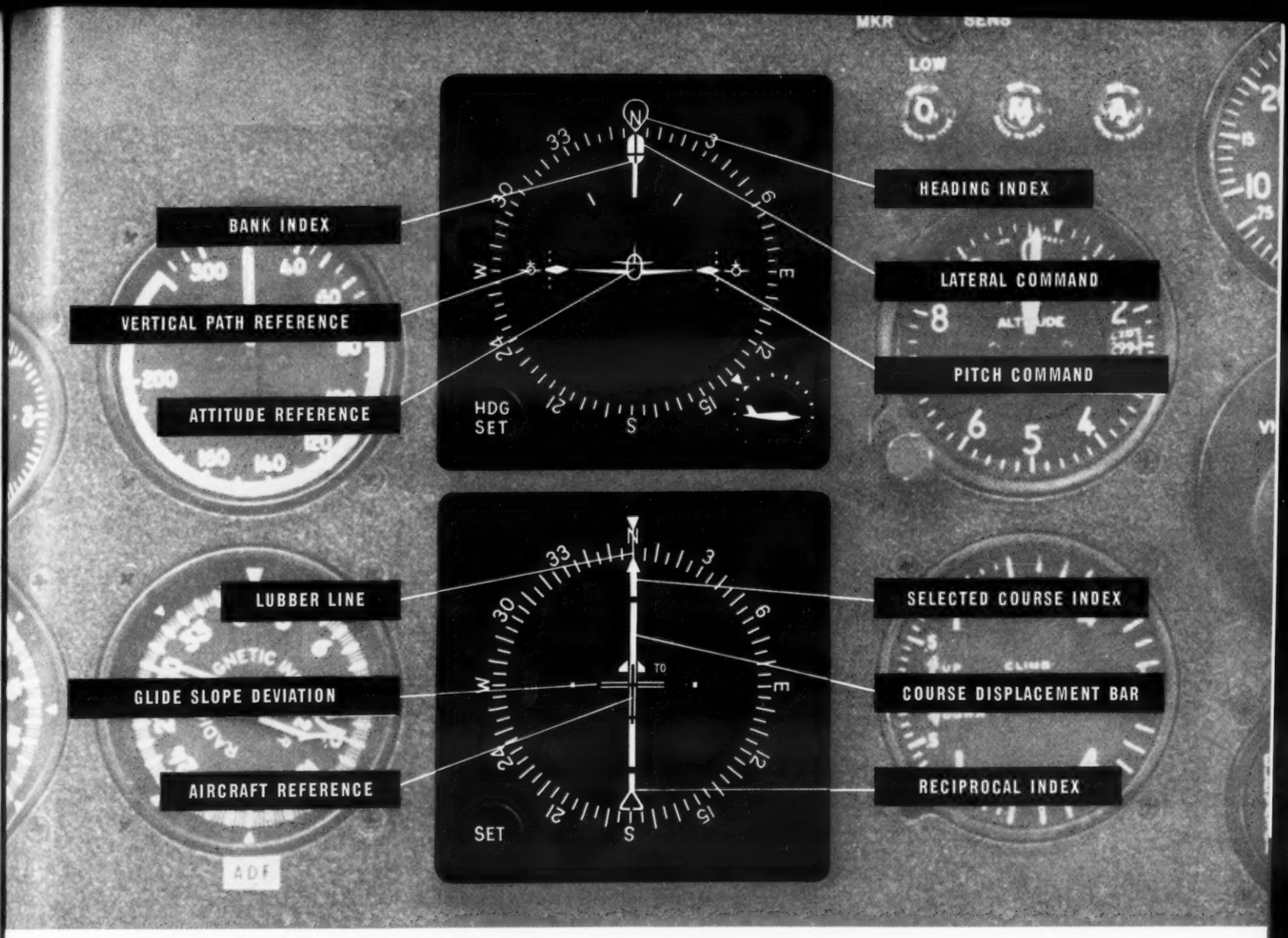

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The Royal Netherlands Air Force's 45th Birthday

The impressive flying display at Soesterberg on July 5th, 1958 formed a fitting conclusion to the series of celebrations organized to mark the 45th anniversary of the Royal Netherlands Air Force. The demonstrations provided a highly compressed but representative survey of the history of military aviation, since they opened with a quiet fly-past by an early French Caudron G-3 reconnaissance two-seater (dating from 1913) and closed with a thundering pass by a heavy Boeing B-52 *Stratofortress* eight-jet bomber which had taken off from a SAC base near Washington to fly non-stop to Soesterberg. Old and new... 45 years of flying history in a few minutes!

The display was attended by the Netherlands Royal Family, Dutch Cabinet members and the Netherlands Chief of Staff, the Chiefs of Staff of the RAF, the French, Belgian, German and Turkish Air Forces, the Vice Chief of Staff of the U.S. Air Force, the Norwegian and the Greek Air Forces, senior officers from various NATO commands, the President of KLM, the Mayors of Utrecht, Zeist and Soest, the diplomatic corps... and 200,000 spectators from all over the Netherlands.

The day's events included not only a demonstration of the Netherlands' air power, but also displays by high-speed fighters, mighty bombers and transports and more harmless aircraft from twelve other NATO countries. In addition to British *Valiant* and *Vulcan* V-bombers, which had taken off from bases in Britain to make a "touch-and-go" landing at Soesterberg, and the B-52 already referred to, spectators had the opportunity to see the USAF's Lockheed C-130 *Hercules* tactical transport in action (an airborne landing by 80 fully-equipped troops) and the unloading of a complete Bristol *Bloodhound* ground-to-air missile from an RAF Blackburn *Beverley* transport. The Lockheed F-104B two-seat version of the *Starfighter*, holder of the world's speed and altitude records, was shown in Holland for the first time, as were also the twin-jet McDonnell F-101A *Voodoo* and the Breguet 1001 *Taon* light strike fighter.

Twelve Republic F-84F *Thunderstreaks* of the Royal Netherlands Air Force demonstrated formation flying and tactical operations, a French *Alouette* helicopter showed off its fire-fighting qualities, and Germany's Dornier Do 27 communications aircraft was put through its paces. Finally there was an in-flight refuelling of two F-100 fighter-bombers by a KB-50 tanker and a brilliant display of aerobatics by American and British teams (the USAF's Skyblazers and the RAF's No. 111 Squadron). The cup for the most accurate formation flying was awarded to the Dutch *Thunderstreak* team from Volkel Air Base, but the latter handed it over to the Italian team under Captain Sguarzino which had been badly handicapped by low-lying cloud.

Dutch F-84F *Thunderstreak* fighter-bombers over the stands.

The Lockheed C-130 *Hercules* turboprop assault transport, in service with the USAF, carries up to 80 fully-equipped troops.

Shown in Europe for the first time: the McDonnell F-101A *Voodoo* twin-jet single-seat fighter-bomber armed with four 20-mm cannon and guided missiles; speed Mach 1.85 and range more than 3,000 miles; service ceiling more than 52,000 ft.; gross weight approx. 44,000 lb.; two Pratt & Whitney J57 engines with reheat.

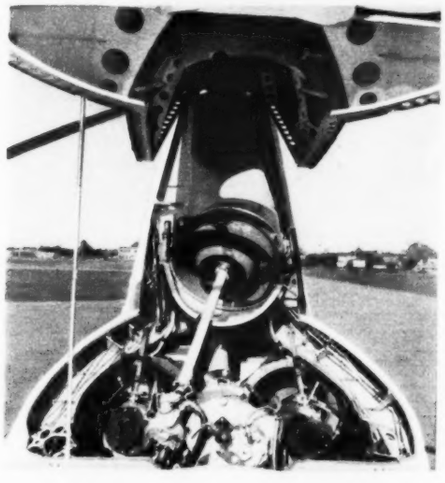
Queen Juliana and Prince Bernhard inspect the Soesterberg band and Air Base company.

New Vertol helicopter. *Vertol Aircraft Corporation, of Morton, Philadelphia, has been testing its new Vertol 107 twin-rotor helicopter since early April. A pre-production batch of ten is being built for the U.S. Army under the designation YHC-1. Seven of the ten will be fitted with two General Electric T58-GE-6 gas turbines of 1,024 h.p. each, while the remaining three will have Lycoming T55-L-1s of 825 h.p. each. Designed as a successor to the Vertol H-21 assault helicopter, the YHC-1 will carry a two-man crew and 22 fully-equipped troops plus commander, or an equivalent cargo load. A civil version promised for 1961 will have accommodation for 25 passengers.*

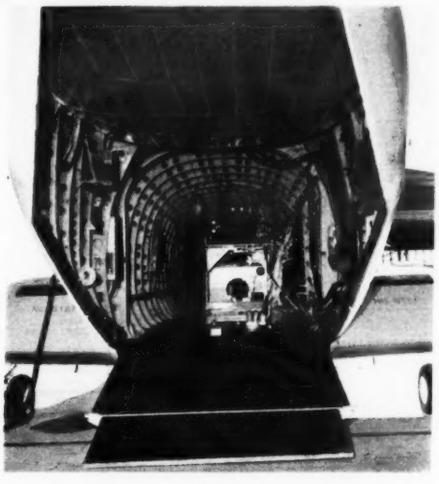
The Vertol 107 features a roomy fuselage of almost square internal section, and a broad loading ramp at the rear. The two gas turbines are mounted side by side on the rear fuselage and drive the tandem rotors via a common gear. As the shaft for the forward rotor runs through a trough on top of the fuselage, the full height of the cabin can be utilized over the whole fuselage width. The undercarriage stubs protruding sideways from the rear fuselage also serve as floats in the event of emergency alighting. Data: length (with folded rotor blades) 44 ft. 3.6 ins., rotor diameter 48 ft. 4 ins., gross weight 15,550 lb.

Progress in Pictures

Large inspection doors provide easy access to gears, cooling fans and engine accessories. The engines themselves can be reached from inside the rear fuselage.



Inside the Vertol 107's roomy fuselage (here packed with measuring equipment). The rear portion of the loading doors opens upwards, the forward portion folds downwards to form a loading ramp.



The McDonnell F4H-1 supersonic Navy fighter *is undergoing several months of stringent flight testing, the results of which will decide whether the aircraft should go into production. At present no fewer than 4,200 McDonnell employees are engaged on the F4H project, so that the employment outlook in this company will be seriously affected by the Navy's decision. Some 1,500 subcontractors have already been included in the programme.*

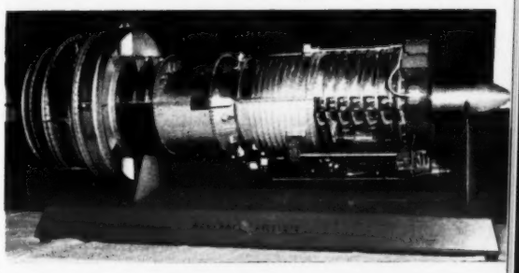
The manufacturers state that the new fighter has the longest range of any Navy fighter so far built and reaches speeds of more than Mach 2. With its extensive and in some cases new-type radar equipment, whose operator sits behind the pilot, the F4H-1 can perform a wide variety of missions against air and ground targets. Its armament comprises either four "Sparrow III" missiles (in the picture, two can be seen to the left of the nose and another two at the rear) or nuclear weapons. Overall length 56 ft., span 38 ft. 5 ins., angle of sweep 45°.

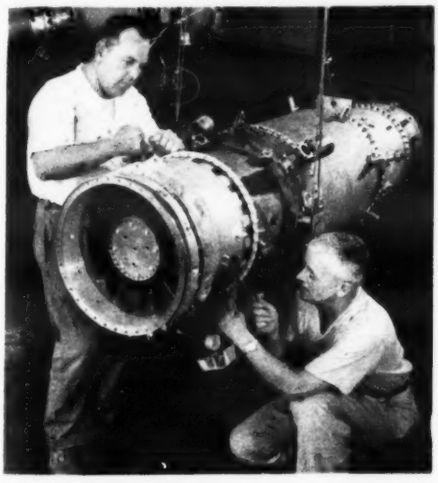
This five-seat multi-purpose helicopter *with gas turbine power was created as a private venture by Saunders-Roe Ltd. in only a few months. Equipped with a Blackburn "Turmo 600" gas turbine, the P.531 is to be offered for communications duties, as light transport, special weapons carrier, trainer, ambulance, and rescue and reconnaissance helicopter. Diameter of the four-blade main rotor is the same as that of the (two-blade) "Skeeter" rotor, and the fuselage is only some 30 inches longer.*

Kaman K-17 *is the designation of this new American experimental helicopter to be used for testing new blade-tip power systems. The 400 h.p. Blackburn "Turmo 600" gas turbine drives a Boeing compressor which pumps compressed air through the rotor hub to the blade-tip nozzles.*

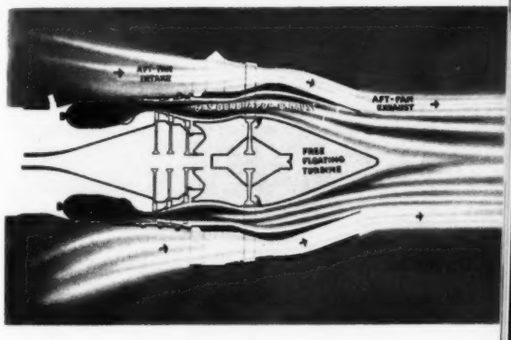
Grumman AO-1 Mohawk for reconnaissance and ground support: *Grumman recently demonstrated to the public a true-to-detail mockup of the AO-1 "Mohawk" multi-purpose aircraft which is under development for the U.S. Army and is scheduled to begin flight testing early in 1959. Picture shows the spacious cabin with full-view windows for the two side-by-side pilots (with Martin-Baker ejection seats), the high-set tailplane, the two propeller turbines (Lycoming T53-L-3s of 1,050 e.s.h.p. each) on top of the wings, and the retractable undercarriage whose three units carry special skis (folded against the fuselage nose and the engine nacelles) for use on snow-covered or soft runways. Air brakes are fitted on either side of the rear fuselage. Photographic and radio equipment is installed in easily accessible bays behind the wings.*

Pratt & Whitney builds lightweight jet engine: *The Pratt & Whitney Division of United Aircraft Corporation is making a bid for a place in the market for smaller jet engines with its new JT-12 engine. Designed for either piloted aircraft or missiles and drones, the engine has already completed important ground tests, including a 15-hour run to missile specifications, the manufacturers announce. Fuel consumption has been found to be lower than originally guaranteed. The single-spool JT-12 is of simple design and develops a static thrust of 2,900 lb. for a weight of only 430 lb. Design work was begun in July 1957, and the first test run was made in May this year.*



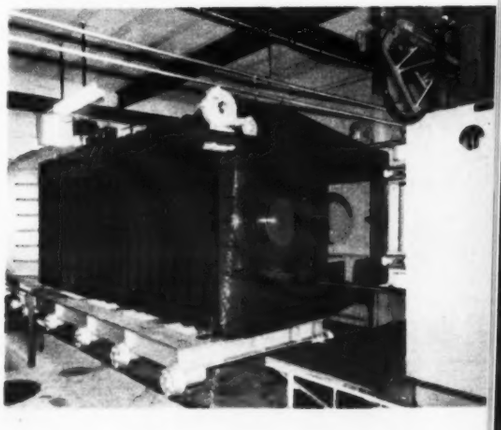


General Electric CJ-805-21 by-pass engine. *The Aircraft Gas Turbine Division of General Electric Company is testing an aft-fan component for its J79 (military version) and CJ-805 (civil version) axial-compressor jet engine. The accompanying drawing indicates the principles of this equipment. The free floating turbine and aft fan behind the structurally unchanged main engine produces—around the hot gas stream from the latter—a second jacket of cold air, which increases take-off thrust by roughly 35% and reduces cruise fuel consumption in the Mach 0.8 to 0.9 range by about 10%. These advantages are obtained by increasing the air flow and reducing the average speed of flow. The manufacturers point out that the fan component can be added subsequently to the completed main engine, without interfering with maintenance or operation. It does not increase starting or acceleration loads on the basic engine. Civil designation CJ-805-21; military designation believed to be J79-2.*

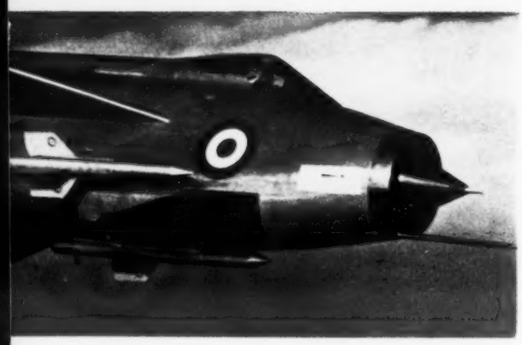


Avro supersonic wind tunnel. *A few weeks ago Avro inaugurated an intermittent blow-down type supersonic wind tunnel at its Woodford, Cheshire, research division. The tunnel was originally designed for aerodynamic tests on the Avro supersonic bomber project (since cancelled) and the stand-off weapon for the V-bombers. The tunnel has a speed range of from Mach 1.6 to 3.5 and is the largest today operating in Britain with this capability. The working section measures 30 ins. by 27 ins., and duration of run is 40 seconds. Before a run, two Broom and Wade compressors pump air into a storage vessel, at the same time cooling and drying it. This air, stored under a pressure of 100 p.s.i., then expands and passes through the working section into the open.*

General view of the flexible nozzle section and working section, and of the diffuser section (right) which contains the model mount.



Telecommunications and Electronics



● **Ferranti Limited** has developed the AIRPASS (Airborne Interception Radar and Pilots' Attack Sight System) fire control system for Britain's P.1B all-weather fighter. The system was recently demonstrated to the German armed forces. AIRPASS comprises an advanced radar unit and a sighting system. The former gives information to the pilot in simple usable form, enabling him to intercept the target and lock the radar beam to it. The radar then automatically tracks the target. It feeds information to the sighting system, permitting the pilot to manoeuvre the aircraft quickly into a suitable position from which to attack with guns, rockets or guided missiles. The radar unit is housed in a single bullet-shaped container which, in the case of the P.1B, forms a complete centre-body in the engine air intake. This has made it possible to equip the P.1B with an advanced radar installation without unnecessarily enlarging the frontal area, at the same time maintaining clean aerodynamic lines. The combination of the radar and the reflector into a single unit has enabled considerable weight savings to be made, particularly as the radar "bullet" forms part of the actual aircraft structure. The packaged design of the AIRPASS is small enough to be installed in lightweight fighters.

● **National Aeronautical Corporation,** Fort Washington, Pa. si producing the Narco Mark V all-channel VHF communications unit for business aircraft use, to be offered at the price of $998. The transmitter portion has 90 crystal-controlled channels for voice communication with a transmitting power of five watts in the 118-126.9 Mc/s band, while the receiver portion covers the band from 108-126.9 Mc/s on 190 crystal-controlled channels, and can therefore be used for the reception of both voice and ILS/VOR signals. Only 29 crystals are employed to provide complete all-channel crystal-controlled transmission and reception. Dimensions of the Mark V: 6½" wide, 3" deep and 12" long: weight 9⅛ lb. The power supply unit weighs only 3½ lb., and measures 6⅜" × 5⅝" × 4½".

● The **SOPEMEA** Type VJ1 g-measuring equipment (for the determination of acceleration) consists in principle of a precision millivoltmeter, which shows the voltage delivered from accelerometers. The equipment is particularly suitable for use with the JP 07 and JP 08 *SOPEMEA* indicators. Characteristics of the g-measuring equipment: 6 measurement ranges (0...1, 3, 10, 30, 100 and 300 g); direct output for the recording of shock accelerations up to 1,000 g; minimum readable acceleration 0.01 g. Some details of the millivoltmeter with Type DJ 1 amplifier: 6 measurement ranges (0...3, 10, 30, 100, 300 and 1,000 mV); 0.2% variation at frequencies from 5 to 20,000 c/s, 0.5% at frequencies from 3 to 24,000 c/s and 5% from 2 to 33,000 c/s. Dimensions: 510 mm × 410 mm × 310 mm; weight 70.6 lb.

● **Marconi Instruments Limited** has developed the apparatus illustrated (Type TF 1601) for the radiographic testing of material; the unit permits the direct visual inspection of small parts by X-ray fluoroscopy, as well as the photographic recording of the X-rays. A 12" × 10" × 5" inspection drawer, mounted immediately above the tubehead, accommodates the test pieces. Facilities for removal of the tubehead make it possible to carry out external radiography of objects too large to fit the inspection drawer.

PAA Dectra Tests

During the months of February, March and April of this year, the Atlantic Division of PAA conducted an evaluation of the Dectra long-range navigation system aboard the Boeing *Stratocruiser* N1036V. The installation included a Decca Mark VIIB receiving system as well as the Dectra receiver. The following conclusions are taken from PAA's report on the tests:

This type aircraft was chosen because a high percentage of its operating time is spent on the routes covered by Dectra. During the evaluation a total of 27 Atlantic crossings were made, all accompanied by an observer trained in Decca/Dectra operations. The total flight hours were 435. The factors of accuracy, ambiguity, continuity of information, service area, reliability, operator time/motion requirements, plus possible improvements were considered.

Within the area of Dectra fixing cover, it was found to be reliable, highly accurate, simple to operate and provided a new concept in the presentation of navigational fixing through the Flight Log (automatic pen recording of position).

The accuracy of Dectra was found superior to the standard navigational systems against which it was checked. The system was found to be almost unaffected by precipitation static and continued to function when all other radio reception was swamped out.

Once the indicators and chart had been set up, operation was completely automatic except for mid-ocean adjustment to compensate for the change in chart scale, requiring less than a minute. Daytime coverage extended from Newfoundland to Ireland and from the Azores to Iceland, while night coverage was substantially greater (because of better propagation conditions for the waves).

The principal disadvantage of Dectra is the lack of fixing cover west of Newfoundland. This could be remedied by the installation of a ranging station on the Atlantic coast of the United States, approximately 1,500 miles from the Newfoundland tracking stations. A second disadvantage is the "lane ambiguity" which has the practical result of requiring that, if full accuracy is to be obtained, Dectra must be initially set up by some other navigational fixing method of similar high accuracy. Where Dectra fixing coverage is available at the departure airport, this may be done on the ground. If Decca is available when entering Dectra cover, an accurate transition can be made in flight; otherwise, Dectra must be set up by some other navigational system which may introduce lane ambiguity errors. Under certain conditions, an ambiguous lane error can grow from a very few miles to very many if not detected and corrected.

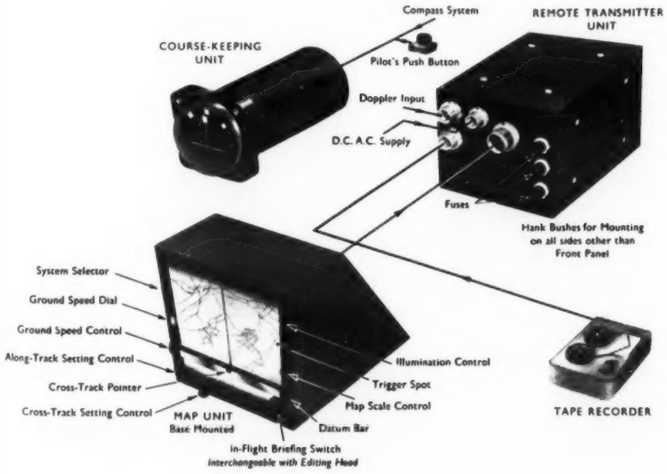
Although Decca is a useful tool in setting up Dectra, the two systems are not necessarily interdependent and if Dectra alone were carried, the only disadvantage incurred in its operation would be the slightly reduced accuracy and facility when setting it up in flight. As Dectra fixing cover was found to be available at the major European terminals during all but the mid-day hours, the extensions of such cover to the North Atlantic terminals would greatly lessen the occasions when airborne setting up would be required.

A combined Decca/Dectra airborne installation of the type installed for the evaluation weighs 210 lb., which includes the special antenna plus all units and interconnecting cabling. Approximately one-third of this weight is contributed by Decca units not directly associated with Dectra operations.

● **Ekco Electronics Ltd.** recently demonstrated a new VHF automatic D/F equipment which is offered at the low price of between £2,000 and £2,300. Designated Type CE178, the cathode-ray direction finder gives automatic display of the sensed bearing of transmissions on any one selected frequency in the 118-132 Mc/s band (picture). The low cost and high efficiency are obtained by using a rotating aerial, instead of a static aerial incorporating an expensive goniometer and more elaborate associated equipment. A prototype of the Ekco Direction Finder has been installed at Southend Municipal Airport for the past twelve months and has been in constant operational use in conjunction with the Ekco Approach Aid for over 6,000 hours.

● After successful testing, **Air Equipement** is now producing the illustrated HF-aircraft radio equipment, which weighs only 40 lb. Remote control selection of 24 channels, 60 W output. Automatic transmitter/receiver tuning and antenna matching.

● **Kelvin Hughes** is producing the Type 2 Map Roller Equipment driven by 'M' type doppler transmission and enabling a prescribed track to be flown, especially at high speeds and low altitudes. The Type 2 equipment comprises three units, the Map Unit, the Remote Transmitter and the Course-keeping Unit. The Map Unit presents a 4¼" wide × 5" long section of a 30 ft. long map strip, driven either by 'M' type doppler transmission or by a manually controlled variable speed drive indicating ground speed on a dial. A position or data bar running the full width of the map carries a pointer giving cross-track displacement. The radius of operation is equivalent to half the map strip length, as the return half is joined to the outward half. Map scale 1 : 250,000 gives 600 nm radius, 1 : 500,000 gives 1,200 nm and 1 : 1,000,000 gives 2,400 nm. Intermediate ranges are of course obtainable and depend on the scale composition. The Course-keeping Unit is essentially a small compass repeater with a 10° port/starboard indicator scale, which can be remotely zeroed by push button control. In-flight briefing facilities are provided by a trigger-head mounted at the edge of the map strip and containing two electrical contacts rubbing over the map surface.



● The **USAF Air Research and Development Command** has now released some information on a recently completed programme of tests with infrared missile observation techniques; the programme was carried out by a scientific team representing all three armed services, the University of Michigan and three manufacturers, with Dr. Max R. Nagel of ARDC's Air Development Center as project director. The tests used missiles launched from the Cape Canaveral range between May 15th and June 15th, with infrared equipment located at the Patrick AFB Missile Test Center and on the eleven missile range picket ships, four aircraft and two islands along the 5,000-mile missile range. It is reported that missile shapes were successfully "measured" by infrared techniques, but a full analysis of the results obtained will not be available for several months, after a symposium and a final evaluation meeting by the fourteen participating organizations.

Air Research and Development Command has also released details of a complex computer and radar system which has been installed at the Air Force Missile Test Center to act as a "Space Traffic Officer" during the firing of ballistic missiles. During the first few seconds after a launching, the IBM 704 computer at the heart of the system decides if the missile is on a safe flight path or otherwise. If the computer indicates an error in course the range safety officer pushes the "destruct" button, destroying the missile in the air. When a successful flight occurs the computer determines the timing for releasing the succesive stages, including the third stage for placing the satellite in orbit. The computer, which provides 20,000 calculations per second and also checks its own accuracy, receives continuous data from eight ground radar antennas, and every ten seconds computes the exact point at which the missile would fall if the thrust of the rocket engines was to fail. Output from the computer is relayed to the central operations room where a range safety officer monitors the flight characteristics on a large map of the firing range on which the computer graphically plots the missile's path or (computed) points of impact. When the computer indicates an impact point outside the range limits the safety officer presses a "destruct" button to detonate a destructive charge in the missile.

● **Ryan Aeronautical Company** San Diego, Calif. is producing a new doppler radar which helps to give Navy HSS-1N helicopters instrument capability in anti-submarine warfare. Designated AN/APN-97, the equipment comprises two units, a radar receiver-transmitter and a power supply-signal data converter. It weighs approximately 30 lb. A number of completely blind landings have been successfully executed with the aid of the AN/APN-97.

● **Compagnie Générale de Télégraphie sans Fil :** The Type AM 210 radio altimeter, designed and produced by CSF, is already installed in French and German interceptors. Following the licence agreement between France and Germany, CSF will also supply this apparatus for installation in the Fouga *Magister* and Nord *Noratlas*. The AM 210 radio altimeter is frequency modulated and provides the pilot with direct and continuous indication of the true height of the aircraft above ground, and also gives a visual signal to indicate arrival at a pre-selected altitude.

Technical data: Two linear scales, with ranges from 0 to 1,000 ft., and from 1,000 ft. to 5,000 ft. The selector permits the aircraft to be flown at a given altitude, ± 30 ft. between 50 and 500 ft., and ± 150 ft. between 750 and 5,000 ft.

● The Electronics Department of **Hamilton Standard** Broad Brook, Conn., has put into production an electronic device to maintain helicopter engines at constant speeds in flight. The unit electronically senses any fluctuation in rotor speed, amplifies the signal and relays it to a servo mechanism. The latter changes carburetter manifold pressure so that the previously selected engine speed is maintained. First installation of this device will be on the Navy's Sikorsky HSS-1N helicopter.

● **Litton Industries** is producing the Model R307/S142 ferrite load isolator for Type DR-19 waveguides as part of a series covering the frequency range from 5,000 to 11,000 Mc/s. Minimum isolation over a 1,800 Mc/s bandwidth is 10 db, but production isolators show less than 1 db loss over most of the bandwidth. Operating power 300 watts CW. Length 5 ins., but this can be shortened to 3.5 ins. without harming electrical characteristics.

● **The International Rectifier Corporation,** El Segundo, Calif. has announced a new high voltage cartridge-type silicon rectifier with peak inverse voltage ratings of from 1,500 to 1,600 volts at rectified d.c. output currents ranging from 210 to 230 milli-amperes. They are particularly well suited for use in airborne power supplies because of their small size.

● The Norden Laboratories Division of **Norden-Ketay Corporation** has recently developed the Airspeed and Altitude Field Test Set, a completely self-contained, portable, automatic instrument for flight line testing of altimeters, Mach meters, airspeed indicators and true airspeed computers. Simplicity of control permits use by unskilled personnel, and the set is rugged and reliable. The manufacturer points out that complete accessories are included for quick and easy connection to aircraft pilot and static systems, enabling the set-up of a ground check of the aircraft pressure instruments to be made in a matter of minutes.

● **Sperry Gyroscope Company,** Division of Sperry Rand Corporation, has developed a helicopter flight control system with a weight of only 40 lb., which provides complete control about all three axes and permits a predetermined altitude to be held.

What's in the Air?

Extracts from Interavia Air Letter, *daily international news digest, in English, French and German. All rights reserved.*

AIR TRANSPORTATION

● **France** notified the United States on July 24th of her intention to terminate the 12-year-old Civil Air Transport Agreement between the two countries. The State Department said that the Agreement would thus terminate on July 24th, 1959, but that this did not necessarily mean that air services between the two countries would cease. A State Department official said that the French action left three possibilities: 1. a new agreement and new routes to be negotiated; 2. air services between the two countries can be continued by mutual agreement; 3. air services between France and the United States could cease in July 1959, when the current agreement terminates, but this is of course extremely unlikely.

● **Royal Air Maroc** has signed a contract for the delivery of one *Caravelle* in May 1960; the agreement was signed on July by Royal Air Maroc's President Laraki and Georges Héreil of Sud-Aviation. At the same time the carrier took an option on a second *Caravelle*. The total firm orders for the *Caravelle* now are 45 aircraft.

● **Silver City Airways,** the car-ferry pioneer which recently celebrated its 10th anniversary, is reported from London to be studying the future replacement of Bristol *Freighters*, and to be showing a keen interest in the AW.650 *Argosy*. This year it is estimated that well over 60,000 vehicles will cross the Channel on Silver City aircraft.

● **Air Charter,** the other car-ferry operator, is also showing an exceptional rise in traffic and is looking round for additional capacity. It is reported that this carrier is at present studying the latest version of the Breguet *Deux Ponts*. Air Charter bookings estimated for the year will exceed 25,000 cars and 100,000 passengers.

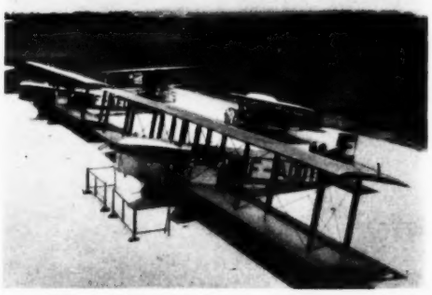
● **Aquila Airways,** Britain's only remaining airline using flying boats, is to cease operations on October 1st, 1958. The decision has been taken for reasons of economy after a succession of seasons during which conditions at Madeira have made operations uneconomic and unsatisfactory. Two Southampton–Lisbon–Madeira return services a week will be continued until September 30th. Aquila's three *Solent* aircraft are to be offered for sale.

● **Olympic Airways** inaugurated a three-times weekly service on the Athens–Zurich–Frankfurt route on August 4th, 1958. The aircraft operated are Douglas DC-6Bs and northbound flights depart from Athens on Mondays, Wednesdays and Fridays; southbound flights depart from Frankfurt on Tuesdays, Thursdays and Saturdays. Olympic Airways thus becomes the 23rd carrier to operate into Zurich on regular schedules.

● **Qantas Empire Airways** will reportedly sell 14 of its 16 Lockheed *Super Constellations* within the next 18 months, according to a report from *Interavia's* Melbourne Correspondent; the remaining two aircraft will be retained to operate the Perth–Johannesburg route via the Indian Ocean, and for freight services to Singapore. Qantas will operate its other routes with Boeing 707/120s and Lockheed *Electras*, with the first Boeings due for delivery in May 1959.

● **Trans-Canada Air Lines** has announced that its fleet of *Viscounts* is to be completely equipped with weather radar, and the installation of Bendix equipment is scheduled to begin in August 1958. TCA has 47 *Viscounts* currently in service and four more will be deli-

Ansett-ANA has ordered six F.27 *Friendship* turboprop transports from Fokker. Left to right: R. Walker, Assistant to Mr. Ansett; R.M. Ansett, Chairman of Ansett-ANA; F.J.L. Diepen, Managing Director, Fokker; J. Gerritsen, Fokker Sales Manager; C.C. Ponsen, Chief of Fokker's Contracts Department.



Henry Farman, French aviation pioneer and aircraft manufacturer, died at his Paris home on July 18th, 1958. Top, Farman (left) and Gabriel Voisin (right) with French Air Minister Louis Christiaens on the fiftieth anniversary of the first flight over a measured base of 1 kilometre (January 13th, 1908). – Below, the *Goliath*, first passenger aircraft built by the Farman company.

NATO's light strike fighter committee recently visited Fiat's Turin plant, where it inspected the T (trainer) and R (reconnaissance) versions of the Fiat G.91 strike aircraft. The visit followed a conference with SHAPE and AIRCENT representatives.

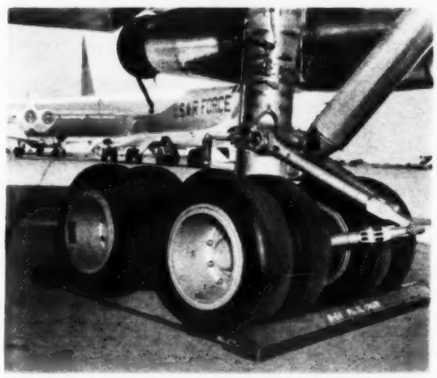
Aeroflot and KLM Royal Dutch Airlines have been operating scheduled air services between Amsterdam and Moscow. Picture shows an Aeroflot Tupolev Tu-104A after landing at Amsterdam-Schiphol Airport.

Both single-seat and two-seat versions of the Hawker *Hunter* are in large-scale production. Picture shows two-seat *Hunter* trainers for the Netherlands and the RAF and (far right) a single-seat *Hunter* fighter for the Indian Air Force. Over 1,200 *Hunters* have been built in the United Kingdom and Europe.

Fifteen American airline operators will operate the turboprop F-27 transport now in production at Fairchild Engine & Airplane Corporation. The first aircraft has now been delivered to West Coast Airlines, which has ordered six.

Hunting H-107 projected short-stage commercial transport for a maximum of 48 passengers. Powerplant two Bristol *Orpheus* jets. Cruising speed 400 knots over stage lengths of up to 700 nautical miles; max. range, still air, 1,350 nautical miles.

Detail pictures of the Convair B-58 *Hustler* supersonic bomber: nose wheel with landing searchlight, and eight-wheel main undercarriage unit.



vered in the spring of 1959. The installation of weather radar and wing-tip tanks in TCA's fleet of *Super G Constellations* is now almost completed.

● **Vickers Armstrongs (Aircraft) Ltd.** has announced that Northeast Airlines of Boston has placed an order for nine *Viscount 754D* turboprop airliners worth almost £5,350,000, including spares. Northeast is also reported to have an option on a tenth *Viscount*. Vickers expects to deliver the first three *Viscounts* to Northeast by the end of August, and they will be employed on East Coast routes.

● **Landing charges** at Amsterdam-Schiphol Airport were increased by 35 percent on August 1st, 1958. Approach and runway lighting charges went up 25 percent. Despite the increase, the tariffs at Schiphol remain the lowest in Western Europe.

● **Moscow-Vnukovo Airport** handles more than 3,000 passengers per day, according to the newspaper "Sovietskaya Aviatsia". The volume of freight and mail handled by the airport averages 3,400 tonnes per month.

INDUSTRIAL

● **New SHAPE/NATO specifications** have been mentioned by various sources; these have been put out to the European aircraft industry and if continued may be backed by Mutual Weapons money. The firms who are so far reported to be interested are: VTO light strike aircraft: Hawker and possibly Breguet; 14-ton helicopter/flying crane: Sud-Aviation and Agusta; assault transport: Hamburger Flugzeugbau, Blume, and Weser Flugzeugbau, an Italian company and Nord-Aviation; multi-engined maritime reconnaissance/anti-submarine: Avro, Fokker, Dornier, Breguet and Sud-Aviation.

● **Hiller Helicopters** is now known as Hiller Aircraft Corporation. Executive Vice President Edward T. Bolton states that the new name has become more suitable because the company's activities for the last five years have been considerably diversified to include many other aircraft fields in addition to helicopter production. A recent further step in this diversification was the acquisition by Hiller of the Adhesive Engineering Company of San Carlos, California. As a new division

These silencers for jet engines designed by French engineer Jean Bertin have been demonstrated on the engine test beds at the Centre d'Essais pour Moteurs et Hélices. Each silencer weighs roughly 22 lb. and reduces noise level by 10 to 13 db, regardless of size or power of the engine. Picture below shows Professor von Karman, Chairman of AGARD, and Engineer Bertin inspecting a silencer.

Production of the *Caravelle* at Sud-Aviation's Saint-Martin assembly plant. So far firm orders have been received for 45 *Caravelles*.

The Grumman *Ag-Cat* agricultural aircraft, which is to be marketed for $17,500.

A new speed record over a 1,000-km stage was set up by a Breguet 1001 *Taon* light strike fighter on July 23rd, 1958 (pilot, Bernard Witt). The aircraft covered the distance in 56 mins 3⅛ sec, and attained a mean speed of 1,075 km/h.

of the Hiller organization, Adhesive Engineering's principal product is a high temperature metal adhesive for use in high speed aircraft and missiles.

● **Lockheed Aircraft Corporation** fulfilled the first *Electra* contract on July 10th, when one of the new turboprop transports was flown from Burbank to the Allison Division of General Motors in Indianapolis.

● **Douglas Aircraft Company** engineers have completed the evaluation of designs for an *Eland*-powered DC-7 and are considering offering this both as a conversion for present operators, and as a new type for line production as the present DC-7C line runs down. It is reported that the DC-7 could be re-equipped with Napier *Eland* turboprops without modification to the wings or airframe.

● **Consolidated Diesel Electric Corporation,** Stamford, Conn., announces the appointment of W. C. Hammond-Adler as Director European Sales with headquarters at 25, Route de Malagnou, Geneva, Switzerland. The production programme of Consolidated Diesel Electric Corp. includes airport towing vehicles, compressors and engine starters.

● **A summary** of RAF *Comet* aircraft achievements, compiled by de Havilland and the RAF, and covering the *Comet's* first two years of service, discloses that the RAF's small fleet of ten *Comet 2s* has logged 5½ million miles—the equivalent of 1,600 New York–London flights. The *Comets,* powered by Rolls-Royce *Avons,* have flown 200,000,000 passenger-miles. One hundred scheduled return flights to the Far East have been made, seventy Atlantic crossings and sixty Pacific Ocean crossings.

● **The English Electric Company** announces that the RAF has ordered a trainer version of the P.1B. Designated P.11, the trainer version has a wider front fuselage with side-by-side seating.

The AW.671 *Airbus* passenger and cargo aircraft projected by Sir W.G. Armstrong Whitworth Aircraft Ltd.

● **The first of the 48 Morane Saulnier MS.760 Paris** twin-jet liaison aircraft for supply to Argentina under the terms of the contract concluded in May 1957 has carried out a flight test programme at the Cazau test centre. The programme included testing of the aircraft's light machine guns, air-to-ground and air-to-air missiles and bombing equipment.

● **Société Turboméca** has received CAA certification of the *Marboré IIC* jet engine and the *Palouste IV* gas generator.

● **Lieutenant General Claire Lee Chennault,** USAF (Retd.), Chairman of Civil Air Transport of China and former Commander of the "Flying Tigers" and the 14th Air Force, died in New Orleans on July 27th after a long battle with cancer. He was 67. Chennault first started flying in 1917 with the U. S. Air Corps. In 1937 an Air Force medical board grounded him and the young Captain, as he was then, left for China and a post as Air Force adviser to Generalissimo Chiang Kai-Shek. After the Sino-Japanese war started, he returned to the United States and recruited volunteers for combat flying against the Japanese. As the "Flying Tigers", they gained fame by holding in check far greater numerical forces of Japanese aircraft. In 1942 they became part of the 14th United States Air Force, with Chennault promoted to Major General and placed in command. He retired in 1945. Civil Air Transport was founded shortly before the end of the Civil War and the Nationalist Chinese Government's withdrawal to Formosa. Chennault died just a fortnight after a bill had been rushed through Congress making him a Lieutenant General.

● **Captain Iven C. Kincheloe,** of the Air Force Flight Test Center, Edwards AFB, was killed on July 26th when his jet fighter crashed and exploded shortly after taking off in the Mojave desert. Captain Kincheloe, 30, was a member of a three-man team which had been training to fly the X-15 research aircraft now being completed by North American Aviation. A detailed description of the X-15 was published in the June 1958 issue of *Interavia Review of World Aviation.*

The Grumman *Gulfstream* turboprop executive aircraft, 25 of which have so far been ordered.

AIRCRAFT AND POWERPLANT

● The first Grumman *Gulfstream* executive transport was scheduled to begin flight testing in mid-August. CAA tests are to follow shortly, and the CAA type certificate in class 4b will be obtained by 1959, when first deliveries are due. So far Grumman has received orders for more than 25 *Gulfstreams.* Data: max. cruising speed 200 knots at 25,000 ft., cabin for 10 to 12 passengers. With full load the *Gulfstream* can use runways of less than 4,000 ft.; max. range 1,910 nautical miles plus reserves. The cabin can be equipped to meet the most varied requirements, accommodating up to 19 passengers. Gross weight 31,000 lb., span 78 ft., length 64 ft.

● Latest design development in the *Bristol Proteus* range of engines is the *Proteus 4.* The intention is that *Proteus 755* engines should be converted into stage 4 units during overhaul by fairly simple modifications. The *Proteus 4* would give 4,695 e. h. p. for take-off, compared with 4,160 e. h. p. for the 755. In addition, there is a 6% reduction in specific fuel consumption in the cruise case. Water injection could be used.

● At a recent exhibition in Trelleborg, *Svenska Flygmotor* showed its VR-3 liquid-propellant rocket engine for the first time. The engine is roughly 3.28 ft. long and approx. 1 ft. in diameter. Weight 165 lb., thrust approx. 5,730 lb. Applications: auxiliary power unit for aircraft or main power unit for missiles.

● *Sir W. G. Armstrong Whitworth Aircraft Ltd.* announces its *Airbus* passenger and freight aircraft, which on route lengths of about 200 miles will feature direct operating costs of less than 2 pence a mile. The *AW.671 Airbus* can carry 96 passengers on its lower deck and 30 on the upper deck. Powerplant, four Rolls-Royce *Dart* turboprops.

● A team of engineers under Engineer Wiktor Narkiewicz has developed a *new 180 h. p. engine,* designated *WN-6,* in Poland.

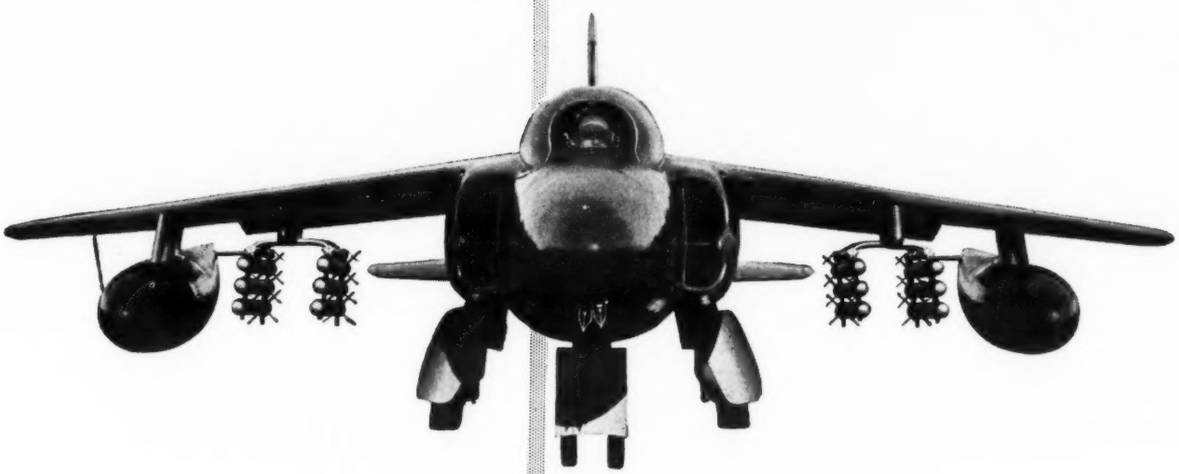
● *VEB Flugzeugwerke Dresden* has completed its fiftieth *Il-14P* transport. The organization also announces that a first prototype of the *Type 153 turboprop transport* will be "ready for the hangar" (completion of final assembly) by the end of 1958.

● Poland's *PZL-102 Kos* (Blackbird) *sports two-seater* began flight testing on May 21st, 1958, it is now announced. The aircraft was designed by the PZL company, of Okecie, Warsaw, who is now preparing for quantity production. The new aircraft, together with the M-2 described earlier, is to be supplied to the Polish Aero Clubs. Motoimport, the State foreign trade organization, also hopes to be able to export both aircraft types.

The PZL-102 is an all-metal low-wing monoplane with fixed tailwheel undercarriage and side-by-side seats. Main wheels have hydraulic brakes. Powerplant, one 65 h. p. WB-1 flat-four; fixed pitch two-blade wooden propeller of the M63/M30 type. Dimensions and weights: span 27 ft. 10¼ ins., length 20 ft. 11 ins., wing area 118.6 sq. ft. Weight equipped 745 lb., max. gross weight 1,257 lb. Performance: at max. gross weight cruising speed is 83 knots; stalling speed 41 knots with flaps down or 44 knots without flaps; sea level rate of climb 492 f. p. m.; service ceiling 10,500 ft.; range 270 nautical miles.

HITTING POWER

2,200 lb. (1,000 kg.) OF
UNDERWING ROCKETS, BOMBS AND
DROP TANKS—PLUS TWO 30mm. GUNS



PERFORMANCE

CLIMB	45,000 ft. (13,700 metres) IN UNDER FIVE MINUTES from Brakes-Off: at operational weight
RADIUS OF ACTION	500 n.m. (950 km.)
LEVEL SPEED	M.98
MANOEUVRABILITY	RADIUS OF TURN at 45,000 ft.—2½ n.m. (4.5 km.)
TAKE-OFF	400 YARDS
LANDING	600 YARDS

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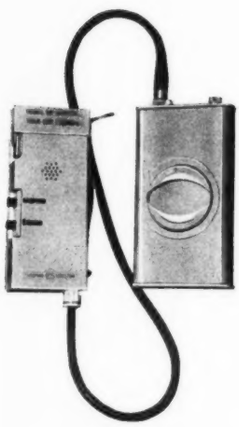
(with tubes or transistors)



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The equipment is actuated by pulling a ring, whereupon the antenna extends, and the set automatically begins to transmit a signal on modulated telegraphy (A 2). Subsequent interchange of communications is made by telephony (A 3) on simplex.

Guaranteed waterproof (tested in 13 ft. of water).
TH. C. 985/986 sets can be preset in the 238-248 Mc/s band or, with modifications, in the 119-224 Mc/s band.

- Endurance more than 30 hours.
- Maximum weight: 1 lb.
- Very low consumption with low-power battery.

TH.C. 985/986

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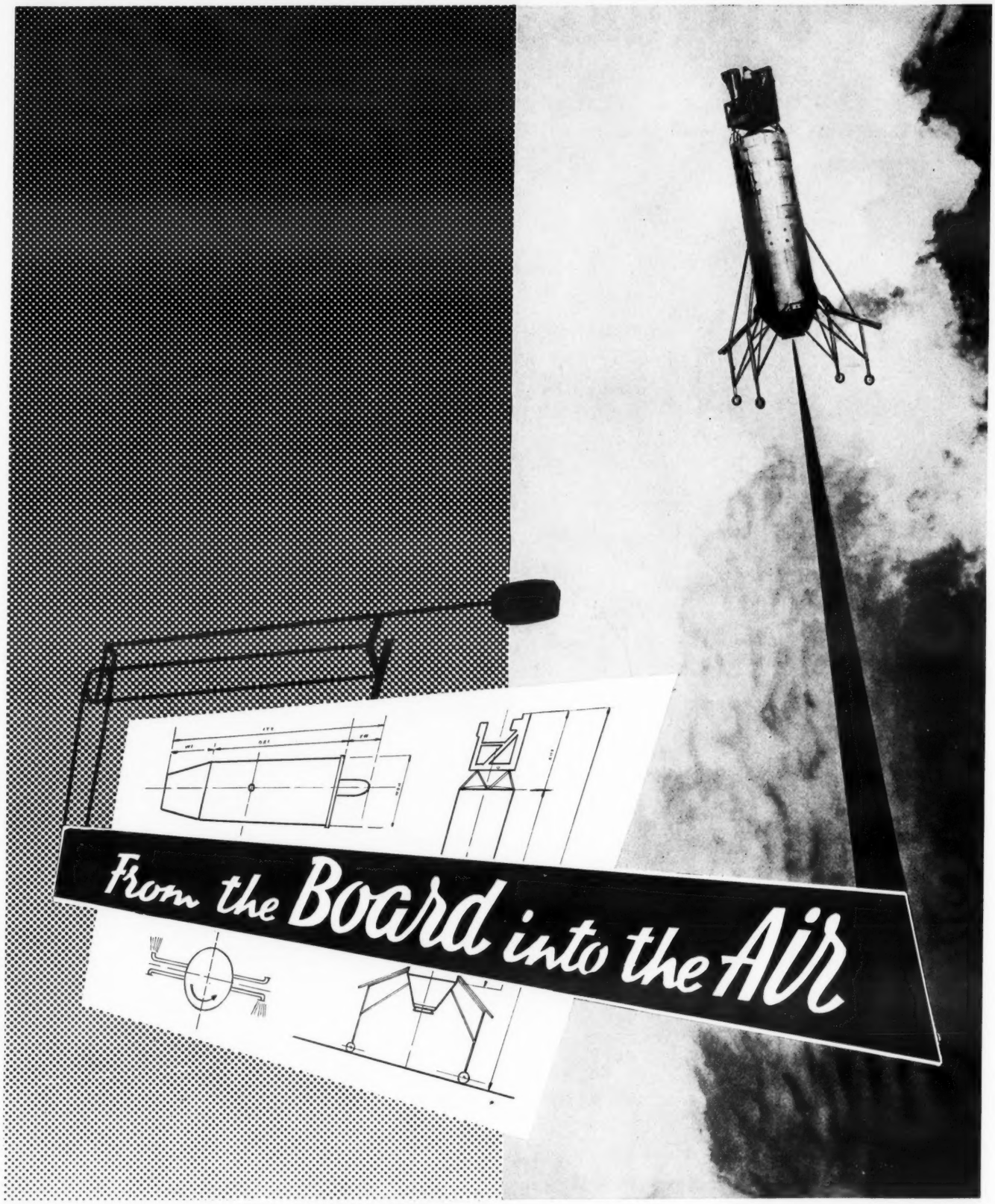

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Guiding the plane with pinpoint precision; telling the pilot his exact velocity second by second; working automatically, continuously, without fatigue – RADAN takes a big load off the rest of the crew. More important, it aids immeasurably in the successful completion of military missions.

RADAN navigators are members of the famed GPL family of Doppler systems developed in conjunction with the USAF (WADC). GPL auto-navigators have literally revolutionized flight. They are the only self-contained systems in the world proved over millions of operational miles.

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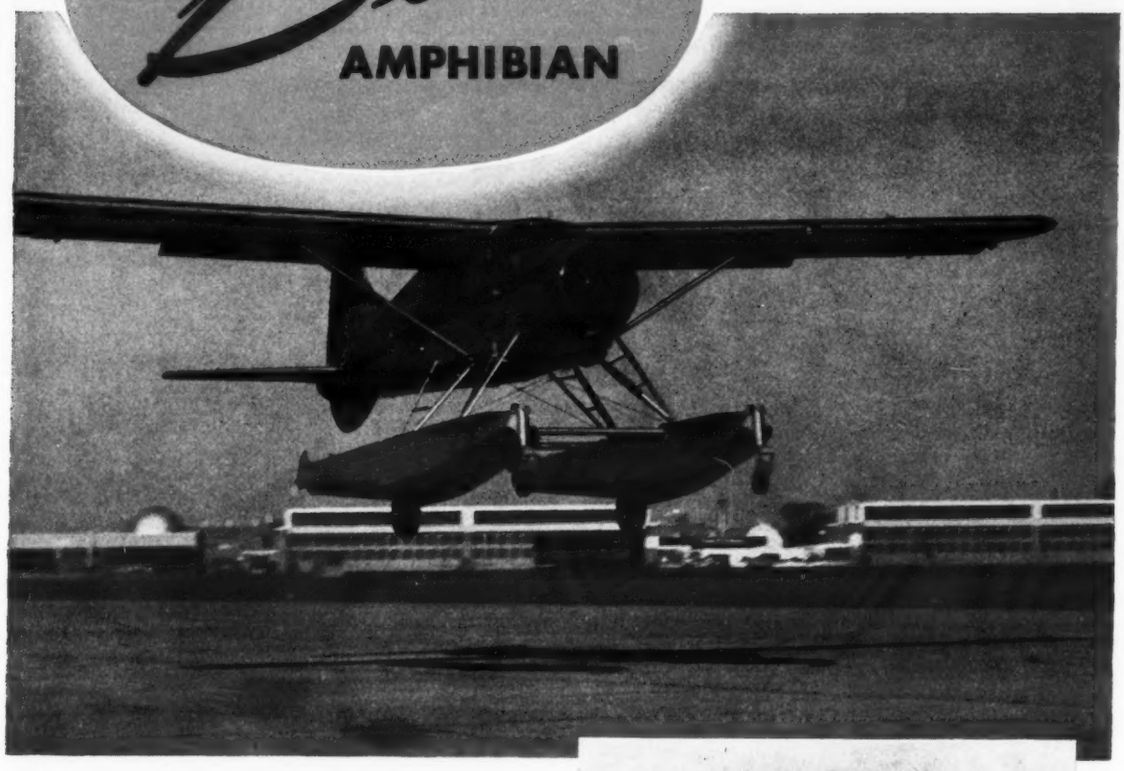
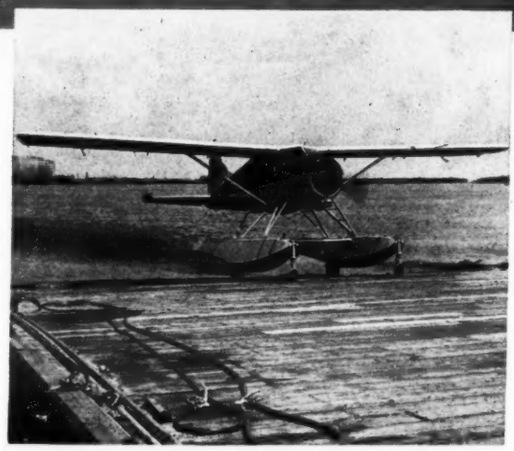
THE *Beaver* AMPHIBIAN





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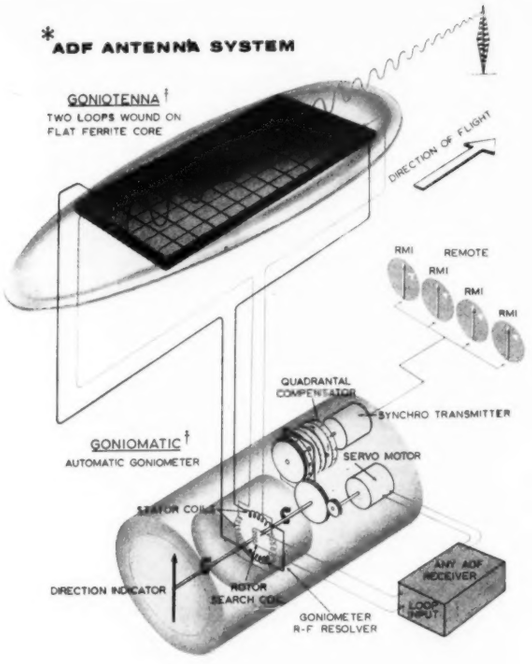

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LOWERS DRAG & WEIGHT

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ADAPTABLE: Lear-Gonio System works with *all* ADF's. CAA (T.S.O. C-41, Category A) approved.

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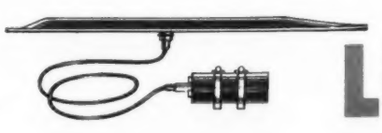
SKIN MOUNTED: Goniotenna attaches directly to aircraft skin – requires no substructure. Needs only one inch hole, solving pressure seal problem. Can be top mounted because of no service requirement.

LOW DRAG: Only one inch high – streamlined.

MORE ACCURATE: Inherently compensates for quadrantal error.

IMPROVED PERFORMANCE: 3 to 8 DB more loop signal adds extra range and signal strength to your ADF.



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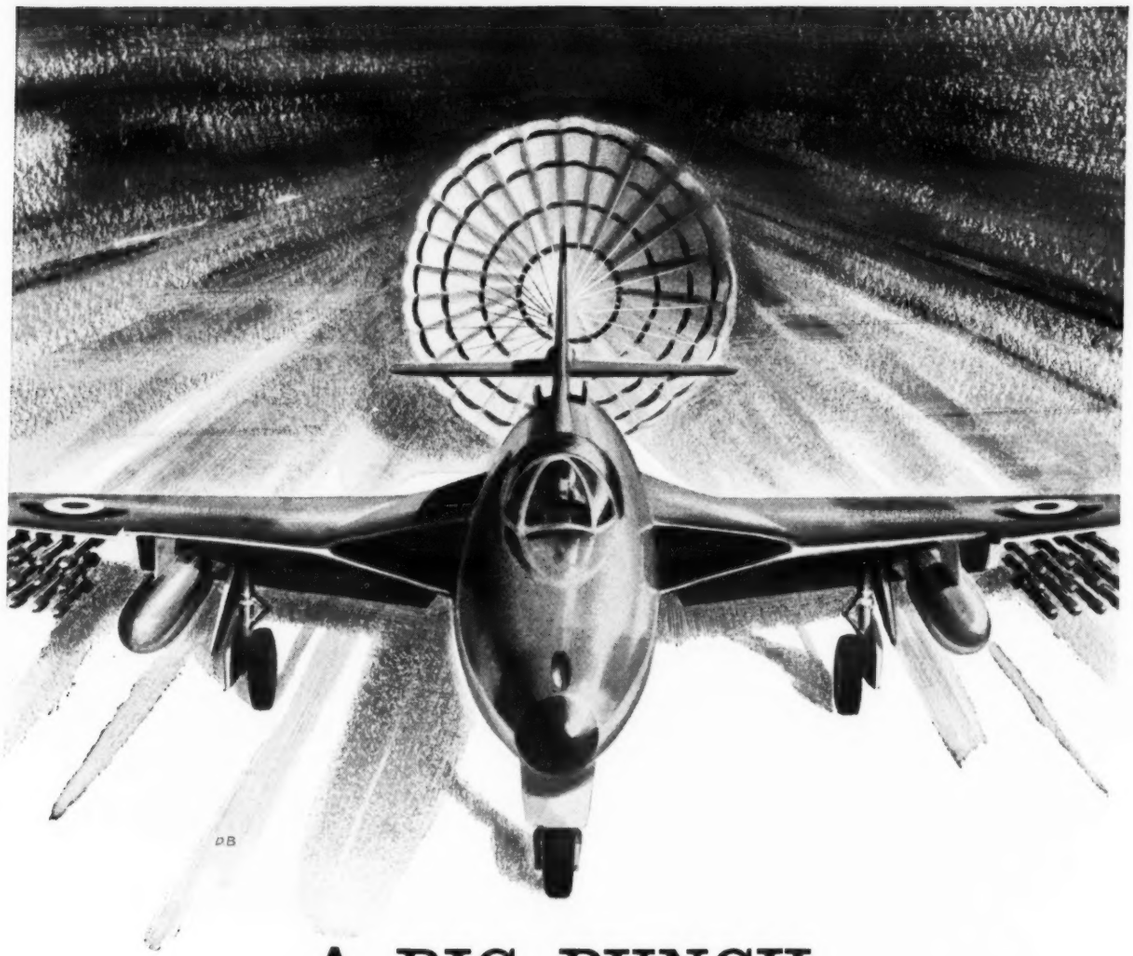

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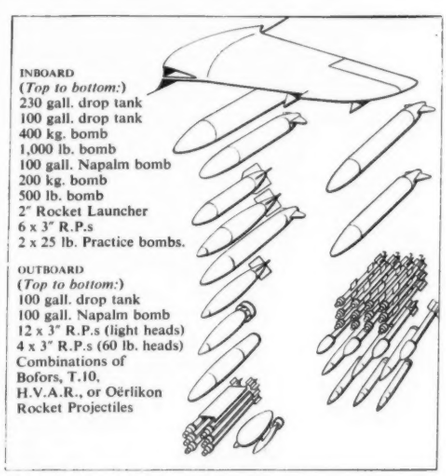

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The Ramjet Engine

By Dr. R. R. Jamison,

Assistant Chief Engineer, Bristol Aero-Engines Ltd., Bristol

Fig. 1 : Artist's impression of the Bristol *Bloodhound* ground-to-air missile in flight on its two ramjets, after the booster rockets have fallen away.

The ramjet engine has now entered service as the powerplant of two surface-to-air missiles, the RAF's Bristol Ferranti *Bloodhound (fig. 1)* and the U.S. Navy's Bendix *Talos*.[1] And as a result of the security restrictions on guided weapons, the ramjet has reached this stage almost unknown even to aircraft technicians.

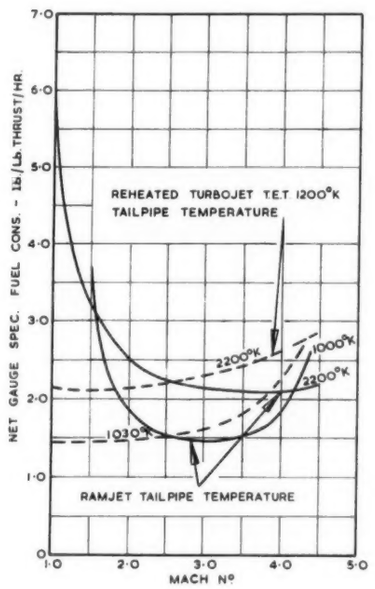
Why has the ramjet been used for guided missiles and not for manned aircraft? The simple reason is that the ramjet is only effective at high speeds, above say Mach 2 (1,320 m.p.h.=2,125 km/h), and guided missiles were designed to operate at these speeds before manned aircraft.

Because the ramjet relies on its speed for compression of the air, and because this compression is essential for good thermal efficiency, the ramjet has a high fuel consumption at subsonic speeds. Between Mach 1 and Mach 2 the specific fuel consumption falls rapidly *(fig. 2)*, and at about Mach 2.5 becomes better than that of the equivalent turbojet.

For an aircraft or missile designed for speeds of this order, therefore, the ramjet must be seriously considered; and the higher the speed, the greater is the advantage of the ramjet. However, fuel consumption is not the whole story. The ramjet, which is essentially little more than a duct, with no moving parts, is inherently very light in weight. At speeds of the order of Mach 1.7 its thrust is sufficiently high to render its thrust/weight ratio equal to that of the reheated turbojet, and above this value the thrust/weight ratio is even better *(fig. 3)*. Taking the effects of specific fuel consumption and specific weight together, therefore, the ramjet is superior to the turbojet even at speeds below Mach 2.5, and with increase of speed both these effects combine to render the ramjet many times superior.

Being an air-breathing engine, the ramjet will not operate outside the atmosphere, though it can build up sufficient kinetic energy within the atmosphere to be able to coast well into space. However, within the atmosphere it is greatly superior to the rocket for anything except the very shortest durations, because the latter must carry a weight of fuel and oxidant equal to about six times the weight of the ramjet's fuel for the same duration. Thus as the range increases from about 25 miles upwards, the rocket-powered vehicle required to carry a given payload will become increasingly bigger than the ramjet vehicle. This trend can indeed be seen in current missiles.

[1] Another ramjet missile shortly going into service is the Boeing IM-99 *Bomarc*, which is discussed elsewhere in this issue.—Editors.



← *Fig. 2 :* Comparison of specific fuel consumption plotted against Mach number. The unbroken lines apply to ramjets with a tailpipe temperature of 1,000°K and 2,200°K, the broken lines to turbojets of the same thrust, without reheat (tailpipe temperature 1,030°K) and with reheat (tailpipe temperature 2,200°K) respectively.

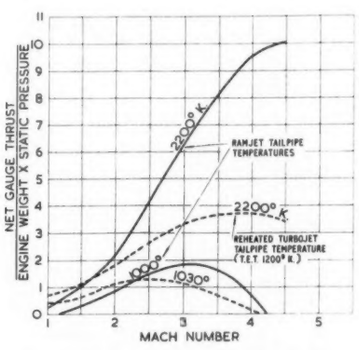


Fig. 3 : Comparison of thrust-weight ratio for the ramjet (unbroken lines for tailpipe temperatures of 2,200°K and 1,000°K), the reheated turbojet (broken line for 2,200°K) and the simple turbojet (broken line for 1,030°K), in all cases plotted against Mach number.

The major problem with ramjets is, of course, take-off and landing. When applied to guided missiles, this can easily be overcome by the use of booster rockets to accelerate the missile to operating speed; the problem of landing generally does not arise ! A different solution must, however, be found for manned aircraft, and especially for passenger-carrying aircraft designed to operate in this speed range, which may be considered as from just over Mach 2 to, say, Mach 4.

This solution is the combination of ramjets and turbojets, which has indeed already been successfully applied in the Nord *Griffon* and Leduc 022 aircraft.[2] Investigation of this combination shows that the two forms of power unit mate together extremely well. The size of the turbojet engines will be chosen to provide a suitable power loading for take-off and landing, and these power units will accelerate the aircraft up to the speed at which the ramjets come into operation. The climb will be continued using both forms of power unit, which will then be throttled back to cruise at the most economical fuel consumption.

The proportion of the total thrust which each contributes during cruising flight will depend on the cruise speed chosen; since the fuel consumption of the ramjet improves relative to that of the turbojet as the speed is

[2] Cf. *Jacques Dupin :* " A Combination Powerplant for High-Performance Aircraft ", in *Interavia* No. 4, 1958, p. 349 etc.

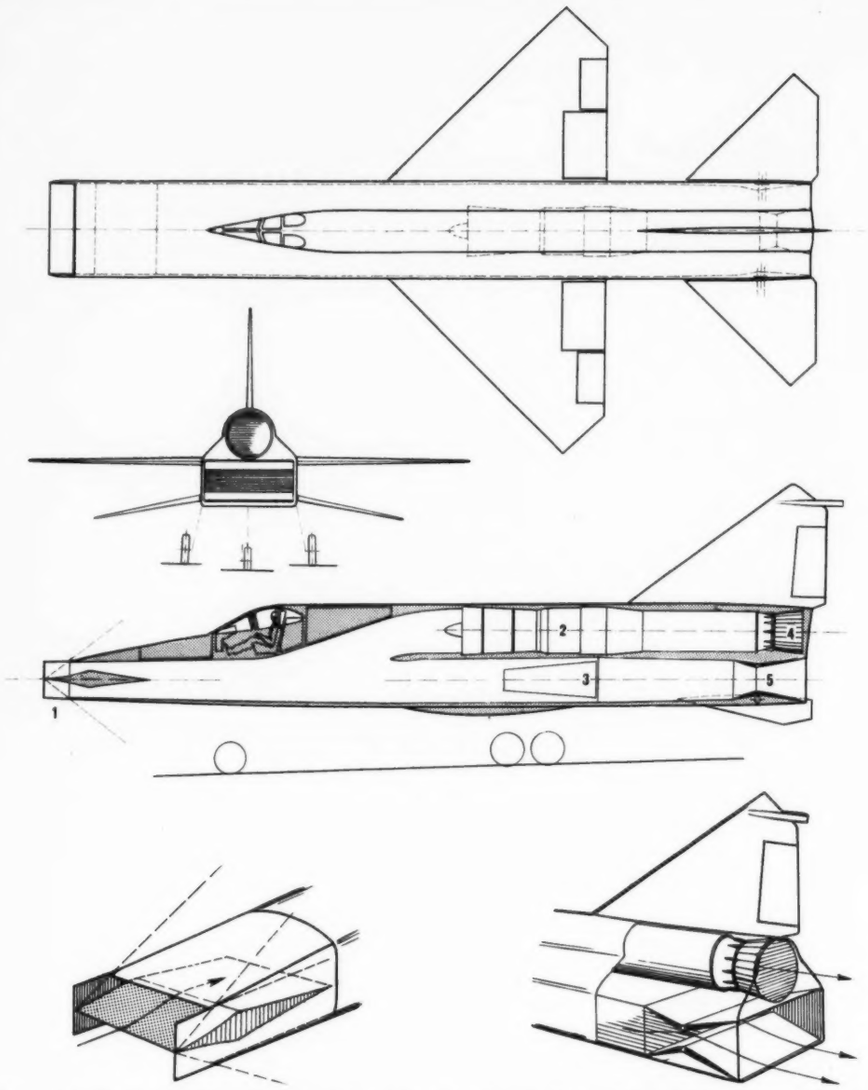
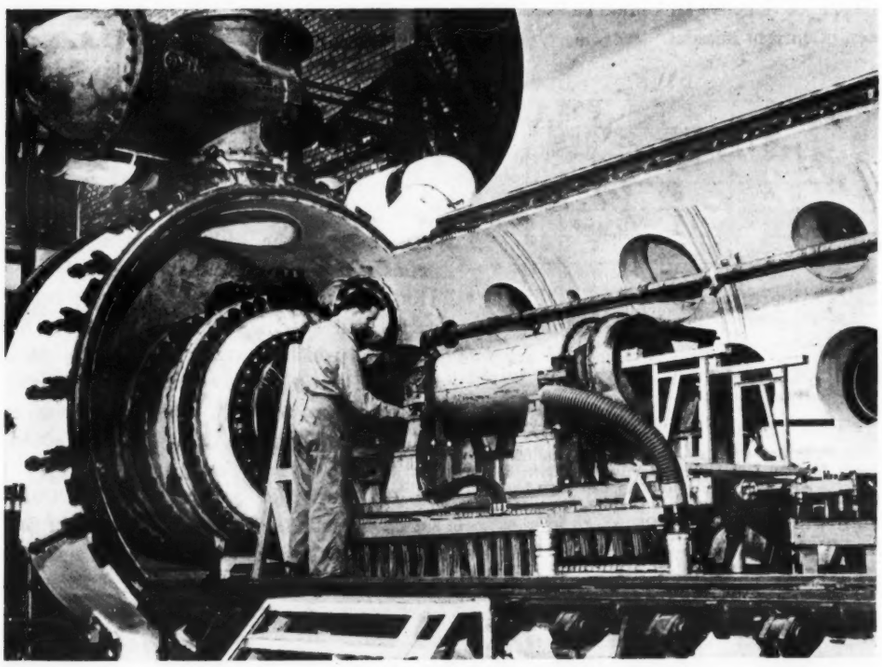


Fig. 4: Principle of a supersonic aircraft (approx. Mach 3) with combination powerplant (turboramjet) and common air intake for both basic engines. 1 – supersonic diffuser with adjustable wedge-type central body ; 2 – turbojet ; 3 – ramjet ; 4 – variable nozzle for the turbojet ; 5 – variable nozzle for ramjet (*Interavia drawing*).



The Bristol high-altitude test plant for ramjets

increased, the higher the chosen cruising speed the greater will be the proportion contributed by the ramjet component. This enables the overall specific fuel consumption, even at a speed of Mach 4, to be maintained at a figure comparable with that of a subsonic turbojet aircraft.

A variable-area supersonic intake will be needed, as for any form of powerplant at these speeds; however, with the turbojet-ramjet combination the problems arising from the range of air mass flows over which the intake must operate are greatly eased, because at take-off speeds the turbojet demands a large mass flow, when the ramjet is inoperative, whereas during cruising flight the ramjet requires a relatively large, and the turbojet a relatively small mass flow. It is therefore convenient to arrange for het turbojet and ramjet to be integrated and to be fed by the same air intake *(fig. 4)*.

Separate convergent-divergent exhaust nozzles will be necessary for the two components, the turbojet nozzle being convergent for take-off and having substantial divergence for high-speed cruising, while the ramjet nozzle will be closed on take-off, to reduce the airflow with the unit inoperative, and will have its largest area during the climb at maximum thrust; after throttling back for cruise, the ramjet nozzle area will be reduced correspondingly *(fig. 5)*.

Studies have been carried out of the performance of an aircraft powered by the combined turbojet and ramjet powerplant—or turboramjet for short—in comparison with other powerplants, which demonstrate the tremendous advantages it possesses for long-range flight at high speeds. As will be seen from *fig. 6*, in which the engine plus fuel weight as a percentage of the take-off weight is plotted against Mach number, for a cruising range of 3,000 nautical miles, the turboramjet is comparable to the normal turbojet at Mach 2, with the reheated turbojet somewhat worse and the turborocket greatly inferior.

With increasing Mach number the superiority of the turboramjet increases rapidly, the lower engine-plus-fuel weight enabling higher payloads to be carried. The normal turbojet becomes rapidly worse, by reason of the increasing engine size needed to produce the same thrust, as the margin between compressor delivery temperature and turbine inlet temperature shrinks. Neither the reheated turbojet nor the turborocket achieve a total engine-plus-fuel weight much better than 60 percent, allowing a bare 5 percent payload if a structure weight of 35 percent is taken.

For 3,000 nautical miles range at Mach 3, the order of payload which can be carried is 2 percent of the take-off weight with the

turborocket, 6 percent with the reheated turbojet, 8 percent with the normal turbojet, and 14 percent with the turboramjet. This last figure makes possible the design of a transatlantic airliner capable of carrying 150 passengers from London to New York in a fraction over two hours, at an operating cost comparable to that of the *Britannia* which now flies the same route.

The nature of the powerplants would also make possible a take-off performance better than that of current designs of jet airliner, enabling this Mach 3 transport to operate on existing air routes.

*

So much for this look into the future; returning to more immediate applications, the characteristics of the ramjet stamp it as an extremely versatile powerplant. In addition to its present use in surface-to-air missiles, it is the most efficient form of powerplant for long-range supersonic winged missiles, both air-launched and surface-launched (complementing ballistic missiles), and long-range supersonic fighters and bombers. Moreover, it also has advantages for use as the second stage of a ballistic missile or space vehicle, to propel it through the atmospheric part of its flight with the minimum consumption of fuel.

*

So far the ramjet has been considered for vehicles with an upper speed limit of between Mach 4 and Mach 5, because this appears to be the approximate limit of speed imposed by kinetic heating on airframes of generally conventional engineering construction, using high temperature alloy skin and insulated interiors with refrigeration. However, there appears to be a range of speeds extending to 5,000 or 6,000 knots (say about 10,000 km/h), in which airborne machines using air-breathing engines could operate continuously For controlled transport round the world this mode of progress appears much more practical than ballistics technique, especially if passengers are to be carried. This could well be a stage in getting load-carrying vehicles into orbit. We cannot say yet just what the prospects of human flight in this hypersonic band will be. It appears on initial survey that it will be possible to construct air-breathing powerplants for these advanced duties, but a great deal of research will have to be done to make them practicable. Not only will there be intense problems of engineering structure at very high temperatures; it appears that the design of hypersonic propulsion units may well differ radically from the accepted shape of a ramjet at Mach 4. As an example, it may be possible, and necessary, to have the combustion of the fuel-air mixture occurring in a supersonic stream, rather than at low subsonic velocities as at present.

Thus, we see that the ramjet, either alone or combined with other power units is likely to prove a potent and versatile propulsion tool in the expanding fields of missiles and supersonic transport aircraft, with an intriguing if as yet a distant prospect at the power unit for hypersonic world travel.

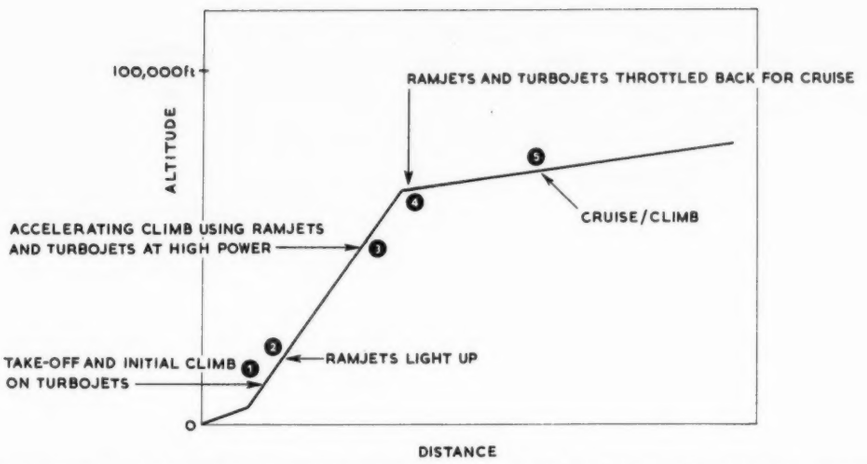


Fig. 5: Operating plan for an aircraft with combination powerplant : 1 – take-off and initial climb on turbojets only; 2 – ramjets light up; 3 – accelerated climb on full thrust of both basic engines; 4 – turbojet and ramjet throttled back to optimum thrust contributions for minimum overall fuel consumption, in cruise; 5 – cruise with optimum L/D ratio at altitudes above 65,000 ft., with aircraft climbing as fuel weight is reduced.

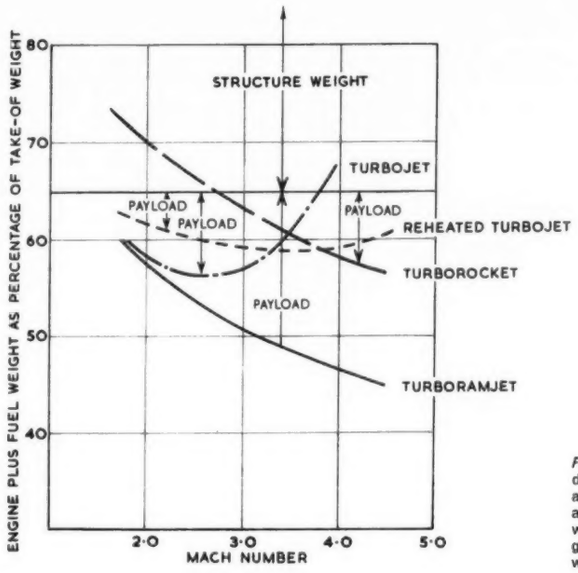


Fig. 6: Engine plus fuel weight for four different categories of powerplant and a 3,000 nautical mile stage, plotted against Mach number. Engine plus fuel weights and remaining payloads are given as percentages of the take-off weight; other details in the text.

An Assessment of the Jet Flap

By James Hay Stevens, A.F.R.Ae.S., London

The scope of this note deals with the " jet flap " as postulated by the National Gas Turbine Establishment of the British Ministry of Supply, and only passing reference will be found to similar work done at the ONERA in France and the NACA in the USA. In fact, pre-War germs of the idea can be traced to aerodynamicists in Great Britain, France, Germany and the USA, although positive experiments appear only to have started about the middle of this century.

So far as the jet flap in its definitive form is concerned it appears to have originated from an observation made by *Hayne Constant* in November 1952 that " *since the propulsive jet of a modern aircraft is a very powerful entity, it ought to be combined one hundred percent with the wing in flight near the ground*". This inspired *Dr. B. S. Stratford*, who was at the time working on simple jet deflection, to investigate whether the ejection of the efflux through a trailing-edge slit would result in a lift-producing entrainment of air over the wing. This idea was initially realised in a small special wind tunnel with two-dimensional models devised by *N. A. Dimmock*. Results were promising and, under the direction of Constant, a full programme was inaugurated by a NGTE team consisting of the two already named and led by *I. M. Davidson*.

As with all British gas turbine and jet propulsion inventions of Governmental origin, the work is being fully covered by patents taken out by Power Jets (Research and Development) Ltd. in most countries in the world—a list of these patents, licences for the use of which would readily be granted, is included within the references.

What is a Jet Flap ?

Despite Davidson's clear and comprehensive exposition of the Jet Flap to *The Royal Aeronautical Society* on October 20th, 1955,[1] there is still much misunderstanding both of the way it works and of its possible application. Probably this arises, in part at any rate, because of the distant relationship to both supercirculation (flap blowing) and to jet deflection, both of which are directly applicable, as modifications, to existing aeroplanes. If, however, as it can indeed be argued with some truth, the jet flap results from a *mariage idéal* between these two simpler devices, then the offspring gives every promise of being a giant who will outshine its parents in every respect !

The jet flap is, in fact, a revolutionary method of flying by the complete integration of propulsion with lift—of engine thrust and wing. It bears a relationship to the conventional aeroplane which is, in some sort, paralleled by the helicopter. The integration of power and lift is, however, much more complete than in the case of an engine whirling a rotor, since it is the actual act of propulsion which creates the ultra-high lift characteristics of the jet-flapped wing.

The principle is simply the ejection of the whole of the engine jet thrust through a narrow slot running across the entire span of the wing trailing edge. By directing this jet sheet downward it has two main effects: it forms a physical barrier to the passage of air flowing beneath the wing—just as does a large Fowler flap—and it entrains the air flowing above the wing, so as to increase its velocity and, in fact, create a vast " suction bubble " above it.

The amount of thrust in the jet sheet and the angle of its deflection both directly affect the amount of lift obtainable, that is the lift coefficient (cf. *fig. 2*).

Tests have been made by the NGTE team using various jet angles, and it appears that about 40° to the horizontal would probably be used for " flaps down ". A most peculiar feature is that a forward suction—additional and in no way related to the horizontal jet thrust component—is created by the airflow entrained round the leading edge, so that even with the jet directed vertically downward there is a resultant forward component. Truly this is integration !

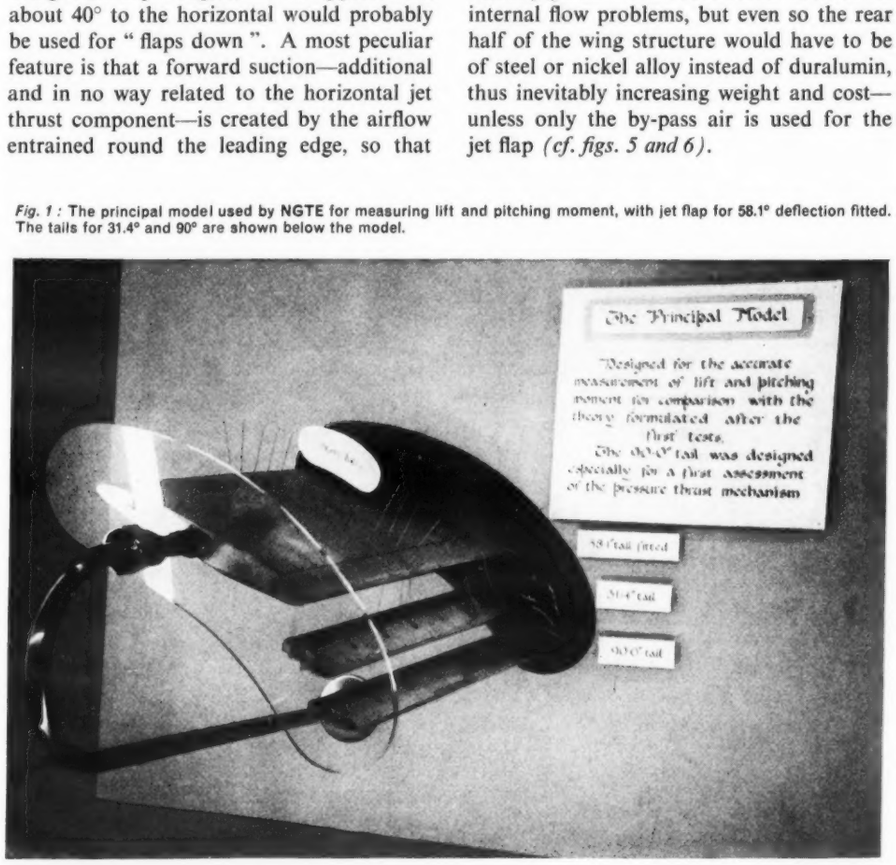
It is foreseen that in cruising flight the jet sheet would be ejected horizontally for propulsion alone and with the wing developing lift conventionally (cf. *fig. 3, top picture*).

How it Works

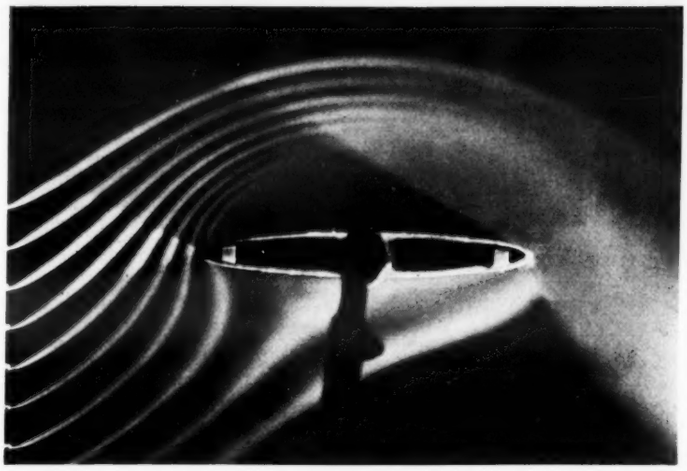
The direction of hot engine gases to, and their ejection from, a spanwise wing slit obviously entails a number of tricky mechanical problems. It is at this point that one does well to recall that this scheme has been propounded by experienced powerplant engineers, who are probably far more aware than are airframe designers of the difficulties of designing ducting to withstand gas wear-and-tear and the implications of frictional losses due to squeezing the flow into queer shapes. This fact, one feels, lends an aura of reality to the jet flap.

Davidson has made it clear that he is considering by-pass engines to provide a high mass flow of relatively cool, moderate-velocity gases. This would solve much of the internal flow problems, but even so the rear half of the wing structure would have to be of steel or nickel alloy instead of duralumin, thus inevitably increasing weight and cost—unless only the by-pass air is used for the jet flap *(cf. figs. 5 and 6)*.

Fig. 1 : The principal model used by NGTE for measuring lift and pitching moment, with jet flap for 58.1° deflection fitted. The tails for 31.4° and 90° are shown below the model.


The Principal Model
Designed for the accurate measurement of lift and pitching moment for comparison with the theory formulated after the first tests.
The 90°-0° tail was designed especially for a first assessment of the pressure thrust mechanism

[1] Cf. " The Jet Flap " in *Interavia* No. 12, 1955, p. 930 etc.



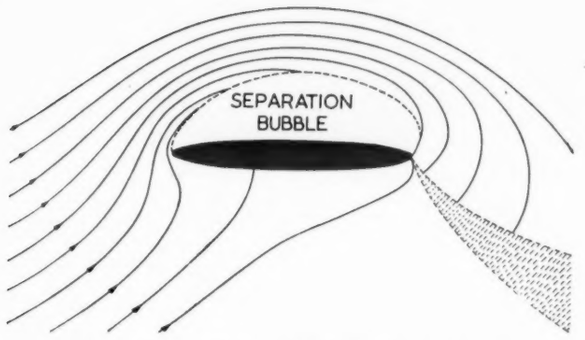


Fig. 2: Left, smoke tunnel photograph of a jet flap model with zero incidence and flow coming from the left: jet angle 58.1°; $C_J = 5$; $C_L = 12.4$. The flow breakaway (separation bubble) is due to the thin, sharp aerofoil and is unlikely with a modern drooped leading edge or boundary layer suction (e.g., through the engine intake). Perspective makes one smoke filament appear to pass through the leading edge. — *Right*, a diagrammatic representation of the flow. (Pictures: *British Crown Copyright*).

Deflection of the jet is a serious mechanical problem, since the structure must here form two very thin lips in the interest of low drag, but the force of the jet would be considerable —say of the order of 1,000 lb./foot run. The scheme suggested is, in fact, to use a small physical flap to induce the jet to change direction by Coanda effect, thus eliminating the thin lips.

This flap, Davidson has suggested, would be perhaps 5 percent of the wing chord—and its use would engender an invisible jet flap equivalent to perhaps as much as 150 percent chord!

Yet the presence of this tiny means to a not inconsiderable end has, one feels, added to the general confusion of the essential difference of the jet flap from other "augmented" physical flap systems. It is perhaps not unnatural that in the USA the NACA should have concentrated upon blowing air over a more or less conventional flap, since this is but an extrapolation of Attinello's super-circulation.[2] Nevertheless, one would offer the opinion that there seems little point in carrying around any more dead weight than is absolutely necessary by having more material in the flap than is required simply to deflect the jet.

Safety

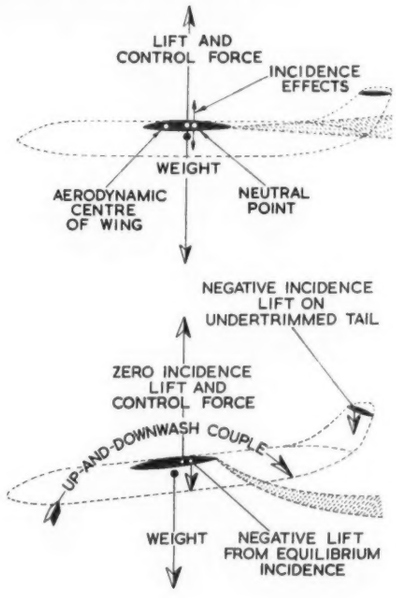
In all "powered lift" systems a new approach to safety has to be made if full use is to be taken of its advantages. It is a case of multiplying the power sources so that engine failures sufficient to cause a catastrophic loss of lift fall beyond reasonable possibility. Likewise there must be no question of disaster arising from asymmetric loss of power. This would undoubtedly entail some ingenious design work to establish ducting, manifolds and crossovers *(fig. 5)* to maintain an even supply across the span under any circumstances.

[2] Cf. "Improving Lift by Boundary Layer Control" in *Interavia*, No. 12, 1955, p. 925 etc.

So far as stalling is concerned it would appear that this possibility could be avoided altogether. While it seems that the entrainment process which "fastens" the suction bubble on to the trailing edge will break down at a low positive angle of incidence, it is nevertheless possible to inhibit the stall entirely by increasing the jet coefficient (C_J)—in practice, that is, by opening the throttle.

All jet lift systems react strongly to ground effect—the ground suction of an underwing jet is now well known—but the NGTE tests suggest that the jet flap should show up well. The presence of the ground distorts the jet sheet quite considerably—one must bear in mind that it is in *fact* a flap of more than a hundred percent chord and a physical one would strike the ground. Davidson has shown curves which suggest that with the wing one chord above the ground, the reduction in lift would be about 20 percent.

Fig. 3: These two diagrams by I. M. Davidson (taken from the "Journal of the Royal Aeronautical Society" for January 1956, by permission of the RAeS) show a jet flap aircraft in cruise (top) and low-speed flight (bottom).— *British Crown Copyright Reserved.*



Balance, Control in Flying

Helicopters are not flown like aeroplanes—they would crash if they were— and it seems reasonable to suppose that a jet flap aeroplane would require a technique of its own. Above all, it certainly does not fit into the airline 1.3 V_S approach, or the normal safety speed at take-off conditions. Before attempting to envisage a "flight plan" a word about balance and control is necessary.

A balancing force will be necessary, as in any other aircraft. Its problems lie in the colossal down-wash change between the cruising and high-lift conditions—something like thirty degrees with a forty degree jet. Apart from the airflow conditions surrounding a tailplane there is the undeniable fact that an upward thrust along the trailing edge must inevitably exert a powerful nosedown couple (cf. *fig. 3, lower picture*) about the quarter-chord lateral axis of the wing, despite the huge upward suction-lift. Davidson has given relevant curves for this in his lecture, while McKinney has offered some figures on possible solutions of the longitudinal trim/control problem in the high-lift configuration. It would seem that, although a tailplane inevitably subtracts lift from the wing, it would require a C_L of the order of only 1.2, whereas a canard would need to achieve a C_L of 3 or 4—which would mean blowing at the least, perhaps even a miniature jet flap. For the tailplane a total movement of about 45° has been suggested to cover the huge down-wash range. Such a surface would almost certainly be of "slab" form with an interlock to the cockpit trim setting so that the aircraft attitude would be maintained constant by the tailplane automatically following changes in down-wash angle.

In his lecture, Davidson implied that a jet

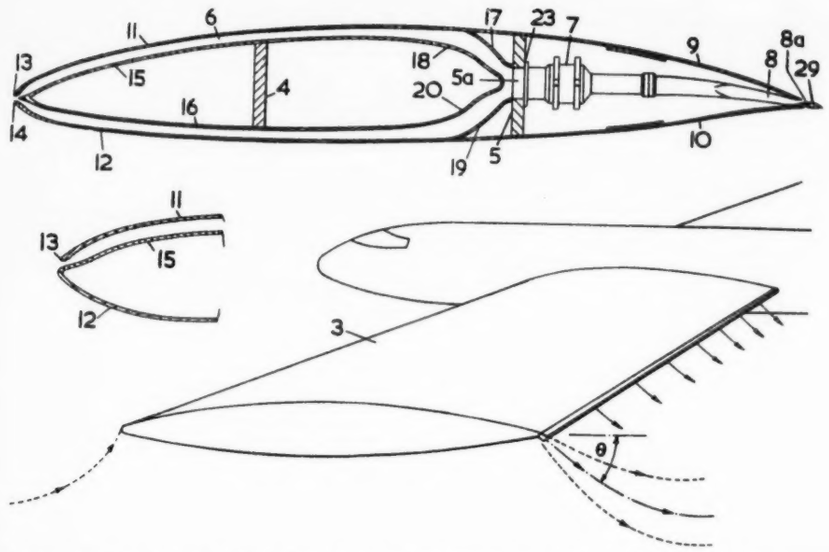


Fig. 4 : Extract from one of the first patents (British Patent No. 787,015) taken out by Power Jets (Research & Development) Ltd. : a jet flap wing with buried engines (7), leading edge air intake slot (13-14) and tiny Coanda deflecting flap (29).

flap aeroplane would maintain a fairly constant attitude, perhaps tilting nose-down when approaching to land. For take-off, upon opening the throttle the aeroplane would accelerate normally to perhaps 50 or 60 m.p.h., when the entrainment effect would be sufficient for it to unstick. Then the enormous lift developed—increasing by a fifth soon after take-off when clear of ground effect—would suck it upward at a very steep gradient. Angle of climb would be adjusted by varying the jet coefficient (C_J), that is by throttle setting which, unlike the conventional aeroplane, has a first-order effect upon lift. Rolling control could be by differential operation of small sections of the Coanda flap, which could also be split to cause shed vortices producing high drag for yaw control.

Although two-dimensional wind-tunnel model photographs show high-lift circulation at zero incidence, finite wing forms with sweepback would require some nose-up attitude at take-off to achieve the steep downwash angles essential for very high lift coefficients—one recalls the apparently exceptional angles of attack of aeroplanes like the delta-wing Avro *Vulcan*.

In cruising flight the jet would be horizontal—giving perhaps 5 percent less effective thrust than jet orifices for the same engines—and the tailplane would operate both as trimmer and elevator. On the approach there would be reversion to thrust control of lift and the aircraft would descend steeply and slowly—the angle of descent being dependent upon the angle of jet deflection and the rate of descent upon thrust. The touchdown, at perhaps 50 m.p.h., would require a burst of power to make up for the 20 percent loss due to ground effect.

It is most important to realise that in the high-lift configuration (take-off and landing) lift is a direct *integration of thrust and wing airflow*. Therefore the jet flap aircraft cannot be thought of as a powered glider, it must

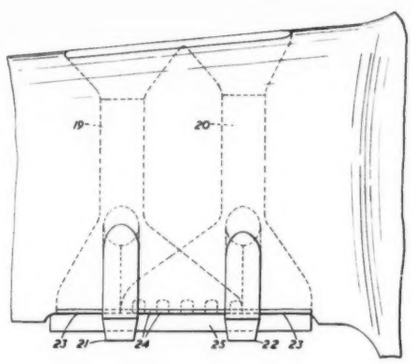


Fig. 5 : A Power Jets (R & D) drawing of a buried by-pass turbojet, or ducted fan, installation. The hot gases from the inner flow are ejected through orifices (21 and 22), while the cold by-pass air is directed by fishtail ducts to the jet flap slits. Crossover manifolds (24) guard against asymmetrical thrust disturbances.

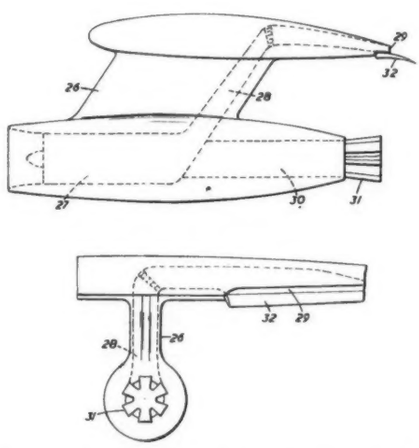


Fig. 6 : Left, another Power Jets (R & D) suggestion for using the by-pass airflow, this time for a pod-mounted engine. A noise-suppressing nozzle (31) is fitted to the efflux jet pipe.

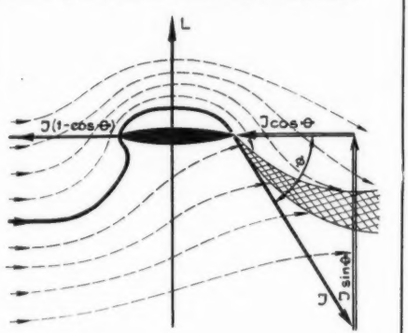
The jet flap inside a momentum box

Those who wish fully to appreciate the aerodynamics of the jet flap should consult the quoted references. The following note is an attempt to précis the basic principle.

In the first place, the Kutta-Joukowski aerofoil theory is inapplicable because the jet sheet, theoretically, divides the upper and lower airflows to infinity. For theoretical purposes the jet sheet is therefore replaced by a momentum flux line, the pressure drop across which is balanced by *centrifugal force* acting upon the jet fluid. To give a finite result, the forces are treated as being in a momentum box. Here total lift is the sum of the nozzle lift (J sin Θ) and the much greater aerodynamic pressure lift (L), while total engine thrust (J) consists of nozzle thrust (J cos Θ) and suction thrust (1—cos Θ). The significant parameter for the behaviour of the system is the jet coefficient :

$$C_J = \frac{\text{gross jet thrust}}{\text{dynamic pressure} \times \text{wing area}}$$

Jet mixing results in the vast entrainment, or sink effect, which can inhibit stall. Whatever the angle of jet deflection (Θ), a forward thrust component is created by suction round the wing leading edge.



be designed so that engine failures cannot reduce the lift, or control, to such a degree that the safe flying technique will demand the virtual abandonment of all the advantages of the invention.

Airworthiness authorities have asked such techniques of conventional STOL aeroplanes, much to their disadvantage, and the jet flap can only succeed if it is regarded as an entirely new system of flying. Davidson has said that we should do well to remember that we are thinking in terms of " putting an airliner down on a cabbage patch at fifty miles an hour ".

Noise

In these days of higher and ever higher thrusts the endurable limit of aeroplane noise is not far over the horizon, while in some cases it has already passed from the irritation level to genuine inconvenience. The relatively quiet turboprop has been virtually by-passed in favour of the large turbojet-powered airliner. Great expense and effort have gone into the evolution of suppressors which will keep the sound of the new 15,000 lb. *plus* engines at approximately the level of the 10,000 lb. turbojets, operators willingly accepting weight, drag and thrust penalties in the interests of quietness.

The seriousness with which noise is viewed by some operators today may be gathered from BEA's suggestion that it regards 90 db at 200 ft. as the acceptable limit for a city-

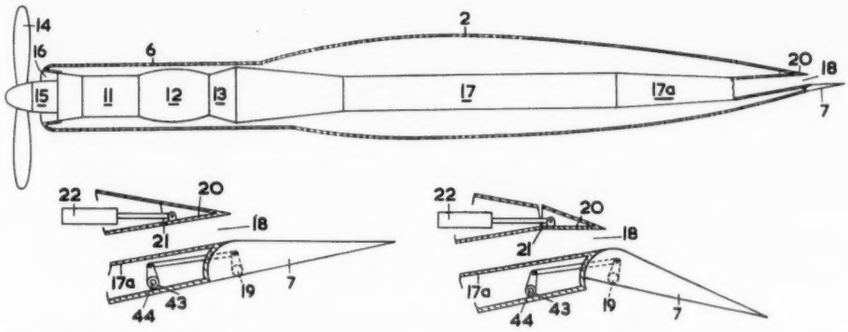


Fig. 7: A Power Jets (R & D) patent suggestion for a turboprop jet flap installation, in which the whole wing would be submerged in slipstream from several propellers. This layout has a larger Coanda flap (7) and a hinged shroud (20) to aid jet deflection.

centre transport—which is less than the rotor-beat of a large helicopter.

The slot " nozzle " of the jet flap would, it is thought, produce far less noise than the conventional orifice of jets totalling a similar thrust. Moreover, the pitch of the sound would be higher and would therefore be dissipated (attenuated) far more rapidly in the atmosphere. A further factor is that the hot high-velocity efflux of the " straight " jet is unsuitable to the aerodynamics of the device, by-pass engines being postulated, i.e., the efflux will be cool, slow—and intrinsically quiet.

A fair example of the noise level would be the passage of a jet bomber—say the *Canberra* or *Valiant*—flying throttled at 200 knots; that is, the sound of the jet flap would bear the same relationship to a conventional jet aeroplane of similar power as does approach idling thrust to full take-off thrust.

Layouts and Applications

In his RAeS lecture, Davidson showed a sketch of a conventional looking high-wing airliner as representative of a jet-propelled jet flap aeroplane. In each wing were quadruple groups of small by-pass turbojets drawing air from a leading-edge air-intake slit and exhausting through multiple manifolds. Much structural ingenuity would be required to install such engines with reasonable accessibility, while avoiding any undue weight penalty. The main difficulty would be to ensure that no drastic loss or assymmetry of lift could occur in the case of engine failure.

It is thought that the jet flap would be fully effective with sweepback of 35 to 40 degrees, which with a thickness of, say, 12 percent ought to give cruising speeds of the order of 500 knots. Such a wing should provide comfortable depth for mounting the engines internally. The writer, while acknowledging the impressive free-flight jet flap model tests done by NACA, feels that podded (or retractable) jets blowing externally on a flap are quite unpractical.

In the case of a delta, or heavily tapered, wing plan, the jet thrust and slit size would be graded proportionally to the fore-and-aft chord width. In this connection there would seem to be a possibility of applying the principle to the Griffith/Rolls-Royce " *Dart* " project as an aid to transition. Among the unknowns of this conception is the way circulatory flow for wing lift can be established in the presence of the linear jet-lift air flow.

Patents on the Jet Flap held by Power Jets (Research & Development) Ltd. at July 1, 1958

Great Britain:	787,013; 787,012; 732,937; 787,014; 787,015; 790,193; 790,194; 790,298; 758,269; 787,011
Australia:	167,541; 200,157; 206,460; 207,539; 204,924; 204,131
Belgium:	527,857; 537,527; 535,418; 551,376; 561,493
Canada:	541,268
France:	1,088,647; 1,100,474; 1,122,779; 1,107,311; 1,122,609; 1,142,268; 1,157,609; 1,163,070
Germany:	1,021,249; 1,013,174; 1,024,364
India:	51,594; 54,204
Italy:	510,292; 531,145; 522,849; 559,477; 559,478; 559,385
New Zealand:	111,416
South Africa:	21,748; 2987/56
Sweden:	162,971
Switzerland:	326,061; 328,649
U.S.A.:	2,756,008; 2,791,089; 2,838,256

Patents have also been applied for in Denmark and the Netherlands, while others are pending in the thirteen countries listed.

There is, too, the possibility of the combination of airscrew slipstream with the jet flap *(cf. fig. 7)*. The jet flap is not, in itself, a VTOL device because there must be relative airflow over the wing to establish circulation. This can be achieved either by forward movement or by " submerging " the wing in slipstream—like the Breguet *Intégral*. This would simply replace the physically visible mechanical multi-slotted flaps by a physical, but invisible, aerodynamic flap. Such an aircraft would be ideally powered by a " supercharged " turboprop, such as the Bristol *Orion*, where the surplus compressor capacity could be tapped and mixed with exhaust for the jet flap efflux.

A small point may be noted here: there seems no reason to expect a jet flap aeroplane to look unconventional, save for its wing leading and trailing edges, least of all is it likely to have large endplates on the wings. Tip losses are invariably compensated better by using the additional weight another way, usually by increasing the span, or perhaps by fitting tip tanks.

Conclusion

In a brief note such as this it is possible only to touch upon some of the more prominent features of the jet flap. After all, it is no modification, it is a new flight system: we are back with the Wrights in 1903, with Cierva in the twenties, or Sikorsky in 1939—*but* with the techniques and knowledge of today for the rapid nurturing of the new conception. One feels certain that the jet flap system is technically feasible and that, correctly used, it could yield dividends; whether its timing is right is another matter. Many a good idea has been stillborn because it came when it was an anachronism. The jet flap has come when money for research is tight, and vested interest in concrete runways is large, so that the dice are loaded. One thing is certain, Power Jets (R. & D.) Ltd. believes in it, as is evidenced by the world-wide patenting of the principle.

Published Literature on the Jet Flap [1]

Davidson, I. M.	" The Jet Flap ", *Jour. RAeS*, Jan. 1956.
Dimmock, N. A.	" An Experimental Introduction to the Jet Flap ", Current Paper 334.[2] " Some Further Jet Flap Experiments ", Current Paper 345.[2]
Long, J. G., Riebe, J. M. and Campbell, J. P.	" The Jet-augmented Flap ", *IAS Reprint 715.*
Maskell, E. C. and Gates, S. B.	" Preliminary Analysis for a Jet Flap System in Two-dimensional Inviscid Flow ", Current Paper 359.[2]
McKinney, M. O.	" NACA Research on VTOL and STOL Airplanes ", *Proc. Sixth Anglo-American Aeronautical Conference* (RAeS/IAS), 1957.[3]
Payne, P. R.	" Jet Drag of Wings with Jet Flaps ", *Aircraft Engineering*, Vol. XXX, March 1958. (*This article must be studied in conjunction with the correcting correspondence from Dr. Stratford published in the May issue.*)
Spindler, R. J.	" Propulsive Wing may be Answer to STOL Problem ", *Aviation Age*, Feb. 1958.
Stratford, B. S.	" Early Thoughts on the Jet Flap ", *RAeS Aeronautical Quarterly*, Vol. VII, Feb. 1956. " Mixing and the Jet Flap ", *RAeS Aeronautical Quarterly*, Vol. VII, May 1956. " A Further Discussion on Mixing and the Jet Flap ", *RAeS Aeronautical Quarterly*, Vol. VII, Aug. 1956.
Williams, J. and Alexander, A. J.	" Three-dimensional Wind-tunnel Tests of a 30° Jet Flap Model ", Current Paper 304.[2]
Zimmerman, C. H.	" Powered Lift Systems ", *Jour. of the Helicopter Association of Great Britain*, Aug. 1958.

[1] Internal reports not available for general sale at the time of going to press have been omitted from this list.

[2] The Aeronautical Research Council publishes certain Technical Reports of government research establishments as Current Papers, which can be purchased from Her Majesty's Stationery Office, Kingsway, London, W.C. 1, England.

[3] These papers emphasise the entirely different NACA approach—and the amount of free-flight model work done in the U.S. version of the Jet Flap.

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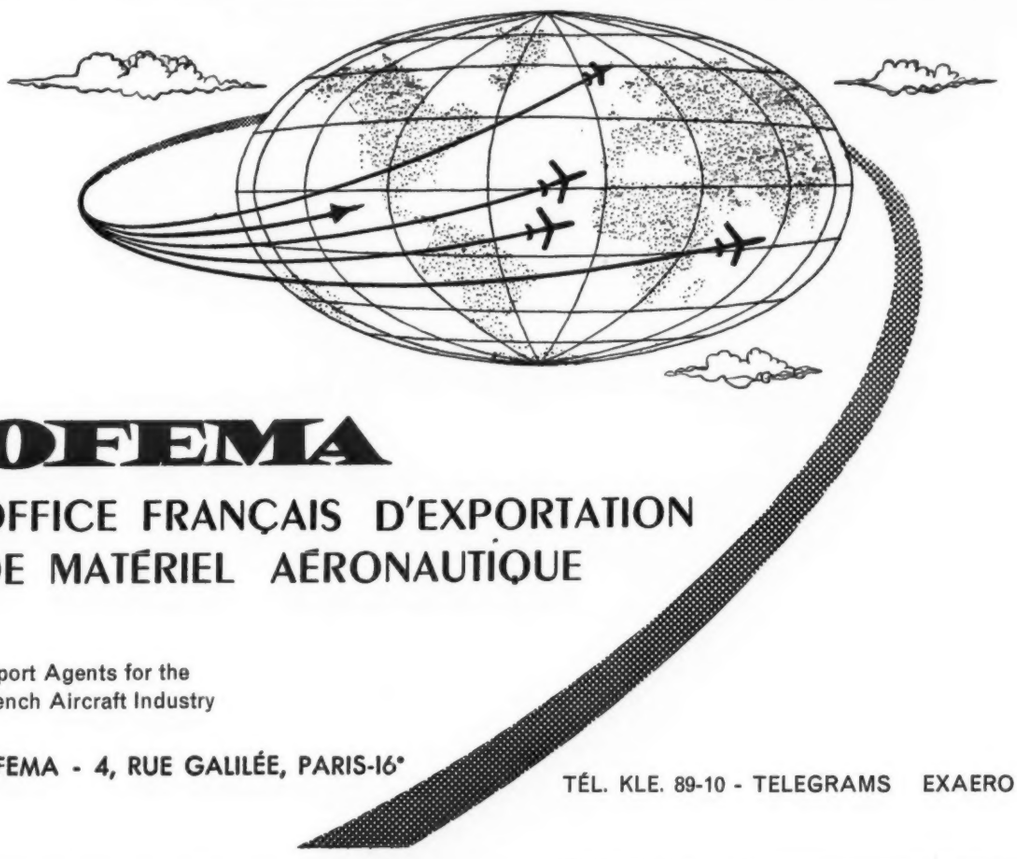

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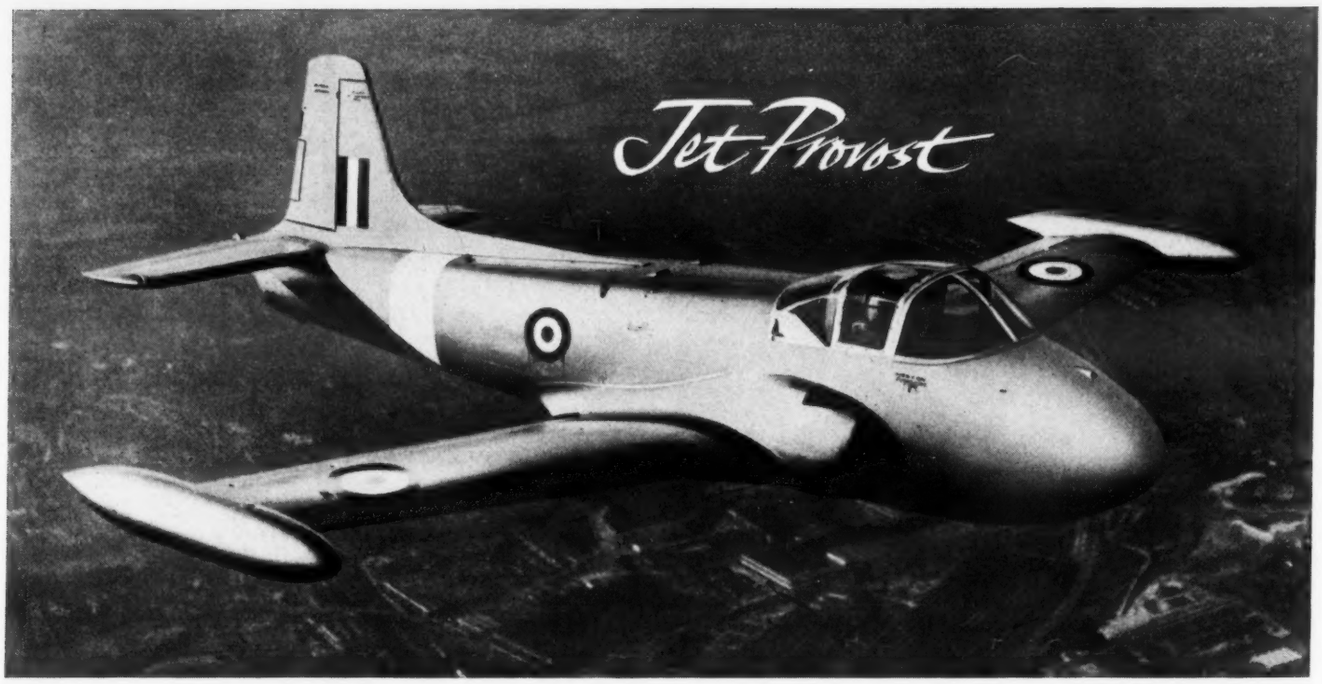

Two years service with the Royal Air Force has established the Jet Provost ab initio/basic trainer as the best aircraft for its purpose, and the Mk3 powered by one Armstrong Siddeley Viper Turbo-Jet is now in production for the re-equipment of Flying Training Command.

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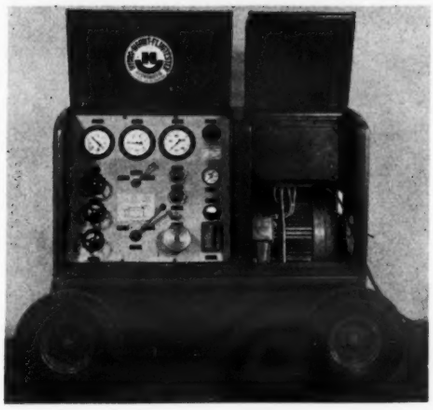
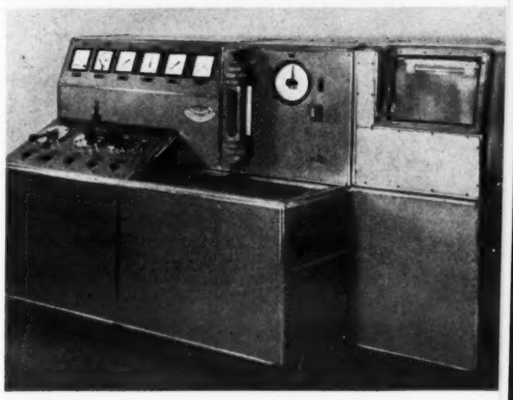




● **Hydromatik GmbH,** of Ulm/Danube, is producing high-performance test equipment for airborne hydraulic systems and has already supplied such equipment to Deutsche Lufthansa AG, Weser-Flugzeugbau GmbH, Messerschmitt AG and Dornier-Reparaturwerft GmbH. The company's production programme covers the following three basic types:

1 — Mobile *Hydro-Gigant* test stand for checking complete aircraft hydraulic systems;

2 — Stationary oil pump test stands;

3 — Special test stands for pressure pistons, oil conduits and hydraulic motors.

The same company's *Hydro-Gigant* axial piston pump with new-type automatic regulator, used in conjunction with the *hydraulic test stand* (above right) reduces the latter's power consumption to such an extent that no undesirable heating occurs even during continuous operation. As delivery volume and fluid pressure can be pre-selected, the speed of reaction of aircraft control processes can be tested under varying conditions. A flowmeter determines whether the pre-selected quantity of oil has in fact passed through the aircraft system and provides an optical check on the hydraulic oil. Large-size suction and pressure filters in the test stand not only protect the aircraft system from impurities, but also enable the system to be cleaned by means of the test stand. Finally, the substantial oil supply in the test stand can be used for rapidly refilling the aircraft's hydraulic system.

Up to the present the *Hydro-Gigant* test stand has been manufactured in versions for delivery volumes of 10 or 20 gals./min (45 or 90 lit/min) and pressures of 3,000 p.s.i. (210 kg/cm²), while the next batch to be produced will be suitable for pressures of 4,200 p.s.i. (295 kg/cm²). No requirement for higher pressures is foreseen for the next few years, though the test stands could be converted at low cost for operation at 5,000 p.s.i. (350 kg/cm²).

A stationary *pump test stand,* which measures pump delivery as a function of rev. speed and load, is shown in the picture on the right below. Equipped with continuously variable drive, oil cooling and two flowmeters for large and small quantities of fluid, the equipment can be used to test all types of hydraulic pumps.

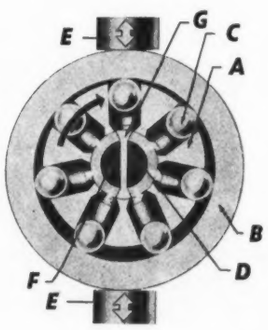
● **Fairey Aviation Company Ltd.** has installed an electronically controlled machine tool which the company has developed in conjunction with Ferranti. Designation: Fairey/Ferranti Three-Dimensional High-Speed Miller. The machine weighs over 50 tons, has a table capacity 8 ft. high and 28 ft. long and machines slab material at speeds of up to 150 inches per minute. The company states that the 3-D Miller can produce machined integral aircraft components up to 30 times faster than any existing system or method in Europe.

The machine is controlled by an automatic control system developed by Ferranti and described in *Interavia* No. 11, 1956 (p. 893). The actual control desk can be seen in the right foreground. The desk converts the control signals (recorded on a magnetic tape) into controlled power for the servo motors in the machine, so that, once the work piece is in place, the whole installation requires only occasional supervision by the operator.

● **General Electric Co.'s** Aircraft Accessory Turbine Department is producing hydraulic constant speed drives for airborne AC electrical systems (400 c/s). They are used to convert the variable speed of the engine-driven input shaft into controlled speed. The compact, lightweight and mechanically simple drives consist of two ball piston hydraulic motor-pump units and a flyball governor providing a steady state speed control of ± 1%.

A ball piston unit is shown in diagrammatic form below. As cylinder block A is turned against the fixed, eccentric race B (by the input shaft), ball pistons C are pushed radially outwards and suck oil into the cylinders via the open inlet D. After rotating through 180° the ball pistons are pushed inwards again by the eccentric race, and the oil flows back under pressure out of the cylinders into outlet F. Delivery volume is varied by displacing the race (by means of two stroking pistons E) in relation to rotor G. The hydraulic power obtained can be used to drive a similar ball piston unit, the speed of which (and hence of the output shaft) is determined by the power supplied. If the eccentricity of the race is reversed, but the same rotation of the cylinder block is maintained, the direction of the oil flow will be reversed.

General Electric constant speed drives for 400 c/s generators are available for output speeds of 4,000, 6,000 or 8,000 r.p.m. All operate reliably at temperatures from −54°C to +135°C. A typical drive for a 40 kVA generator for input speeds of 4,300 to 8,000 r.p.m. and an output speed of 6,000 r.p.m. weighs 52 lb.



Nice-Côte d'Azur Airport

The French Riviera Airport at Nice was opened to civil traffic in 1946 and, since that date, business has become ever brisker. Traffic figures have climbed rapidly, aircraft movements have increased regularly, and the individual aircraft using the airport have, in step with the times, become larger and heavier. In short, the airport administration was soon faced with the necessity for undertaking reconstruction work to expand the facility to meet the ever-increasing demands being made upon it. Because of the nature of the location, surrounded on two sides by the Mediterranean and the River Var, and the character of the terrain, expansion of the delta-shaped airport raised many problems, which have required detailed and lengthy studies. Finally in 1953 the responsible authorities approved the plans which had been drawn up, and reconstruction work could be commenced; in December 1957 France's Minister for Public Works and Transport handed over the new installations for operation.

At the present time Nice Airport has an approx. 200-foot-wide main runway running from Southwest to Northeast (QFU 05/23) with a length of 7,200 feet, and which could be extended to 8,200 feet without any great technical difficulties; additionally the airport has an emergency runway 130 feet wide and 5,575 feet long, running almost parallel with the main runway. The 3,540-foot by 260-foot apron area contains sixteen aircraft stands each of 214 feet diameter, and is served by an 82-foot wide taxi track. Taxiway length totals 11,150 feet, the majority being 82-foot wide. The airport's modern terminal buildings cover an area of 753,500 sq. ft., and fuel tankage contains a total of 330,000 Imp. gals.

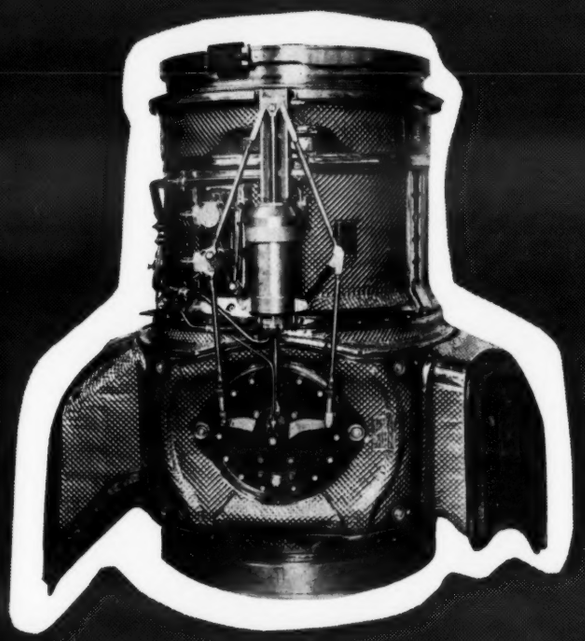
Traffic Figures for Nice-Côte d'Azur Airport

Year	Aircraft Movements	Passengers	Freight and Mail (in Tonnes)
1946	5,091	34,230	—
1947	9,079	70,997	—
1948	10,114	89,249	—
1949	13,864	178,339	—
1950	16,572	224,723	—
1951	18,343	316,824	2,475
1952	19,559	358,040	2,539
1953	20,241	410,300	2,173
1954	20,768	453,360	1,906
1955	19,485	465,441	2,174
1956	22,791	562,672	2,881
1957	23,262	601,114	3,091

Nice-Côte d'Azur Airport has the normal runway, threshold, obstruction and taxiway lighting but, due to the difficulties of the terrain and the prohibitive costs, no approach or other lighting is available. The same technical difficulties have up to now prevented the installation of radio landing aids such as, for example, an ILS system. However, an MF radio beacon, located some 4 miles to the Northeast and on the line of the main runway, permits approach flight even under conditions of comparatively bad visibility.

However, the general atmospheric and weather conditions in the Nice area are so favourable that Nice-Côte d'Azur Airport is heavily employed as an alternative airfield. Statistics record that for only 36.6 percent of the time is the cloud base below 3,300 feet, and below 1,650 feet for only 5.4 percent. Horizontal visibility below 5,500 yards has been recorded in only 1.52 percent of the observations carried out, and below 2,200 yards, which only occurs with precipitation, a factor of 0.25 percent.

Some indication of the importance which Nice-Côte d'Azur Airport has developed is given by the following figures: Approximately twenty capital cities or main towns on four continents are linked by direct flights to Nice, and the airlines operating into the airport comprise four French and ten foreign carriers. All these airlines are individually represented in the city of Nice, and a further ten British charter carriers are represented, for the most part, by Société Aérovar.



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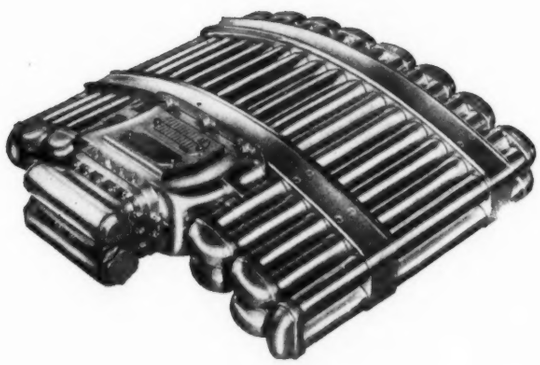

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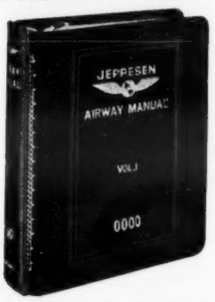

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Book Reviews

Books received

Technische und volkswirtschaftliche Berichte des Wirtschafts- und Verkehrsministeriums Nordrhein-Westfalen, edited by Prof. Leo Brandt:

Report No. 44 : Die Bestimmung der Flugzeugpolaren für Entwurfszwecke, by Dipl.-Ing. Dietrich Fiecke, 1958, printed in manuscript form.

Report No. 45 : Bedarf an Flugplätzen für den Gelegenheitsverkehr in Nordrhein-Westfalen, by the Institute of the Transport Sciences, University of Cologne, 1958, printed in manuscript form.

Die Luftkräfte am Flugzeug — Parts I and II, by Dr. Winfried Braun (price DM 9.60).

Einführung in die Flugmeteorologie — Parts I and II, by G. Roediger.

Published in the "Flugtechnische" Reihe ; Verlag Richard Carl Schmidt & Co., Brunswick, 1958.

Wissenschaftliche Ergebnisse der Deutschen Atlantischen Expedition auf dem Forschungs- und Vermessungsschiff "Meteor"; edited by A. Defant for the Deutsche Forschungsgemeinschaft ; Volume XVI — First part — Die Höhenwinde über dem Tropischen und Südlichen Atlantischen Ozean (including Deutsche Seewarte measurements up to 1939) and statistical examination for selected areas, by Erich Kuhlbrodt. — Verlag Walter de Gruyter & Co., Berlin, 1958 (price DM 27.00).

Mitteilungen aus dem Institut für Flugzeugstatik und Leichtbau an der Eidgenössischen Technischen Hochschule in Zürich; edited by Prof. Dr. M. Rauscher:

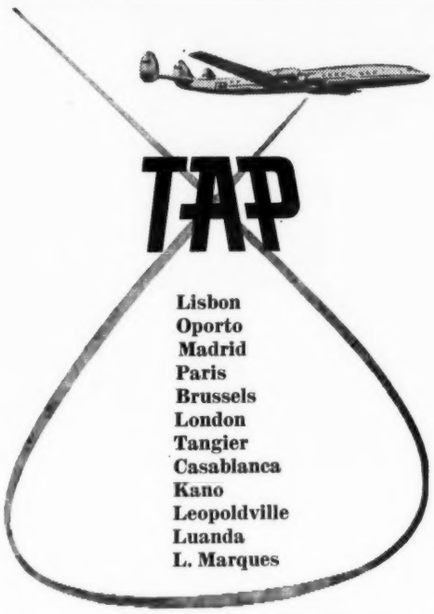
Report No. 4 : The Finite Twisting and Bending of Heated Elastic Lifting Surfaces, by Raymond L. Bisplinghoff. — Verlag Leemann, Zürich. 1958.

Praxis des Reisefluges für Privatpiloten. — Copress Verlag, Munich, 1958.

Prüfungsfragen für Privatpiloten. — Copress Verlag Munich, 1958.

Jahrbuch der Luftfahrt 1958 — Luftfahrt Taschenbuch. — Edited by K. F. Reuss, assisted by K. A. St. Jentkiewicz. — Südwestdeutsche Verlagsanstalt GmbH, Mannheim, 1958.

A letter from East Berlin : A correspondent from East Berlin comments as follows on the article entitled "The Aircraft Industry in East Germany" by Rolf Stainer, published in the July issue of *Interavia* (p. 720 etc.) : "The article contains a number of inaccuracies. Nobody here knows how the price of DM330,000 was arrived at for the Il-14. In reality the price would work out more in the region of $290,000. The twin-turboprop Type 153 is not destined to replace the four-jet Type 152, but to perform tasks now carried out by the Il-14 and DC-3. Finally, the report that a jet interceptor is under development is unlikely to be true, since under the programme which shares out responsibilities among the Socialist countries the East German Democratic Republic has taken over purely civil tasks, in particular the development and construction of short and medium stage commercial transports and sports aircraft. Other Socialist countries presumably have better resources for building fighters and other military aircraft."



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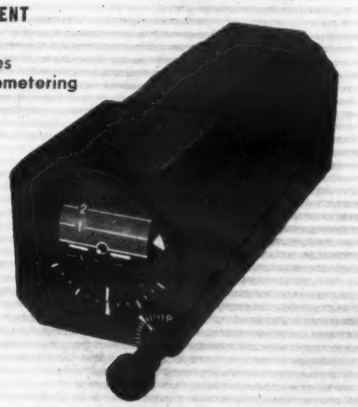

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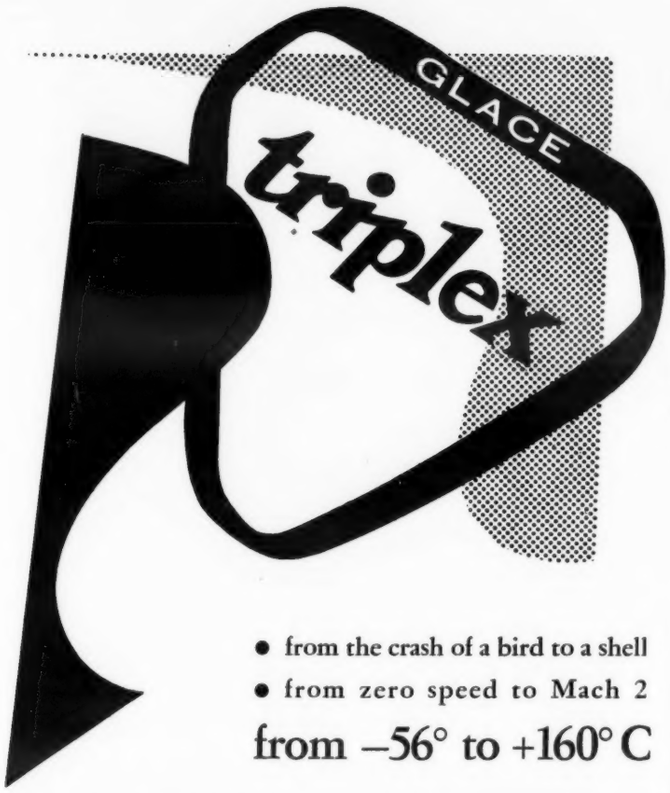

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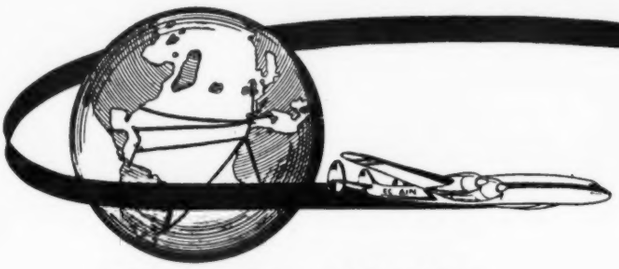

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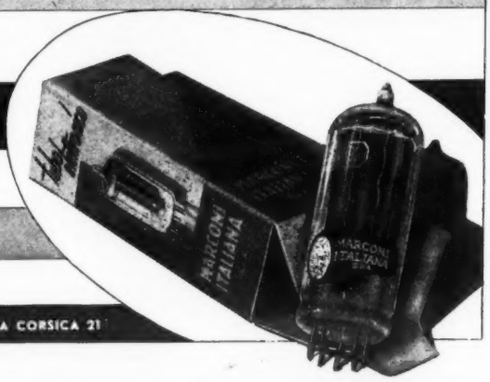

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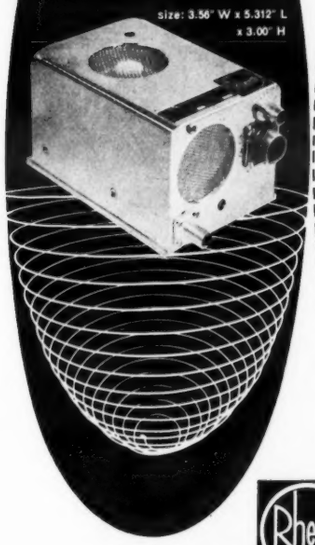

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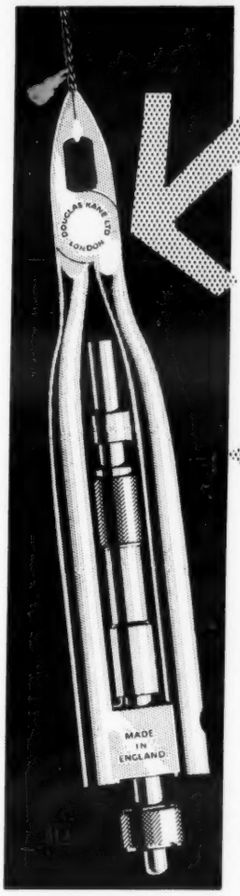

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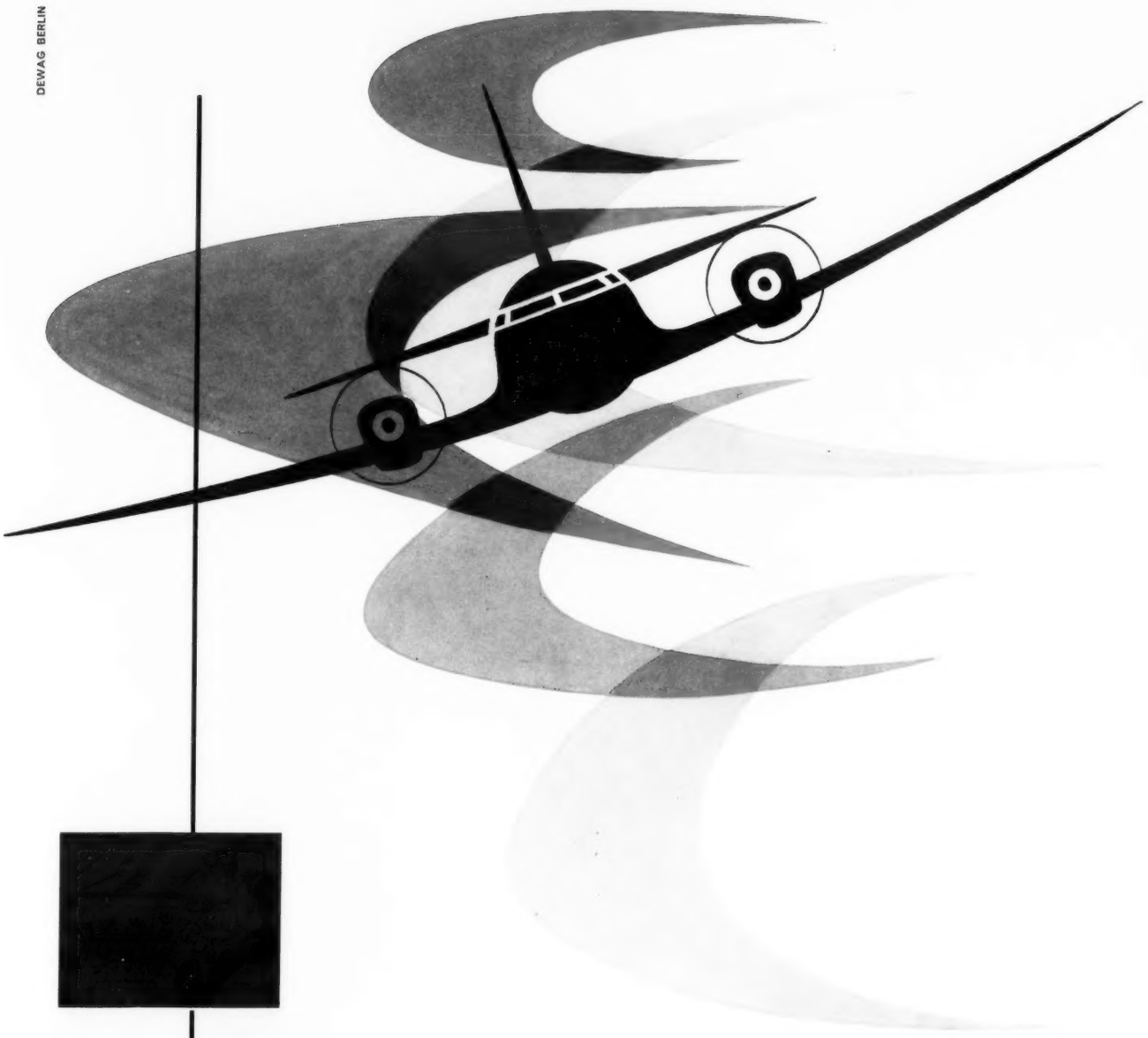

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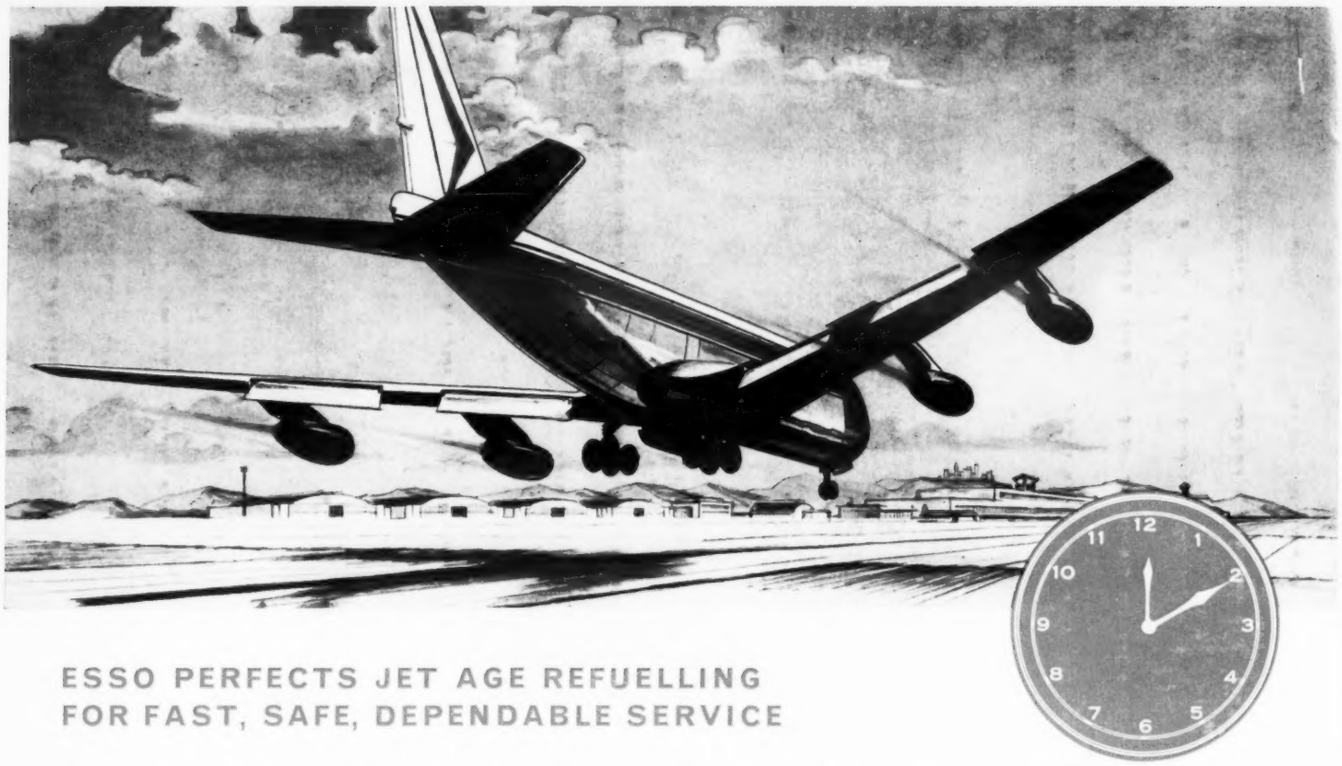

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